NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedure overview of extracorporeal shockwave therapy for Achilles tendinopathy

Achilles tendinopathy is a condition of the tendon that connects the calf muscles to the heel bone. There may be tiny tears in the fibres of the tendon. It is usually caused by overuse or injury. Symptoms include pain, weakness or stiffness in the lower calf and back of the heel. In extracorporeal shockwave therapy a machine is used to deliver sound waves to the painful area. It is thought that extracorporeal shockwave therapy may stimulate healing.

Introduction

The National Institute for Health and Care Excellence (NICE) has prepared this interventional procedure (IP) overview to help members of the Interventional Procedures Advisory Committee (IPAC) make recommendations about the safety and efficacy of an interventional procedure. It is based on a rapid review of the medical literature and specialist opinion. It should not be regarded as a definitive assessment of the procedure.

Date prepared

This IP overview was prepared in August 2015 and updated in May 2016

Procedure name

- Extracorporeal shockwave therapy for Achilles tendinopathy

Specialist societies

- British Orthopaedic Foot Surgery Society
- British Society for Rheumatology
- British Society of Skeletal Radiologists.

Description

Indications and current treatment

Achilles tendinopathy is characterised by chronic degeneration of the Achilles tendon and is usually associated with injury or overuse. Symptoms include pain, swelling, weakness and stiffness over the Achilles tendon and tenderness over the heel. Achilles tendinopathy is classified as insertional or non-insertional. Insertional Achilles tendinopathy occurs at the bone-tendon junction in more active people, and non-insertional (or mid-portion) Achilles tendinopathy occurs more proximally in older, less athletic and overweight people.

Conservative treatments include rest, application of ice, non-steroidal anti-inflammatory drugs (NSAIDs), orthotic devices and splints, physiotherapy, Achilles tendon exercises or stretching, topical nitroglycerin, low-level laser therapy, and injections with corticosteroid or autologous blood. Surgery may rarely be considered in patients with refractory symptoms with the aim of repairing partial tears in the Achilles tendon.

What the procedure involves

Extracorporeal shockwave therapy (ESWT) is a non-invasive treatment in which a device is used to pass acoustic shockwaves through the skin to the affected area. Ultrasound guidance may be used to assist with positioning of the device. The shockwaves can be either focused or unfocused (often referred to as radial shock waves). The focused shockwaves are generated using electrohydraulic, electromagnetic or piezoelectric energy. The unfocused shockwaves are generated pneumatically.

Treatment protocols for ESWT vary according to the energy density and frequency of shockwaves. ESWT may be applied in a series of treatments or a single session. Local anaesthesia may be administered before treatment because high-energy ESWT (>0.12 mJ/mm^2) can be painful; however, there is evidence that local anaesthesia may influence the outcome of ESWT. Low-energy ESWT (EFD ≤0.12 mJ/mm^2) can be used repeatedly and does not need local anaesthesia.

The mechanism by which this therapy might affect tendinopathy is not known.

Outcome measures

Roles and Maudsley scale: 4-point rating scale used to report results of ESWT from 1 to 4 (1 = excellent result, no symptoms, 2 = good result, significant improvement, 3 = fair result, somewhat improved, 4 = poor results, same or worse symptoms).

Functional Index of Lower Limb Ability (FILLA): validated lower-limb-specific activity questionnaire (the scale of this index is not reported).

European quality of life 5 dimensions questionnaire (EQ-5D): a commonly used standardised instrument for measuring general health status. The 5 self-reported dimensions are mobility, self-care, usual activities, pain/discomfort and anxiety/depression.

Victorian Institute of Sport Assessment-Achilles (VISA-A) score: validated 8-item questionnaire of Achilles tendon problems rated from 1 to 100 (an asymptomatic person would score 100).

Ankle Hindfoot Scale (AHS): questionnaire assessing the severity of pain, the function, and the alignment of the ankle and hindfoot, rated from 0 to 100 (an asymptomatic person would score 100).

Literature review

Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to extracorporeal shockwave therapy for Achilles tendinopathy. The following databases were searched, covering the period from their start to 11 August 2015: MEDLINE, PREMEDLINE, EMBASE, Cochrane Library and other databases. Trial registries and the Internet were also searched. No language restriction was applied to the searches (see appendix C for details of search strategy). Relevant published studies identified during consultation or resolution that are published after this date may also be considered for inclusion.

The following selection criteria (table 1) were applied to the abstracts identified by the literature search. Where selection criteria could not be determined from the abstracts the full paper was retrieved.

Table 1 Inclusion criteria for identification of relevant studies

Characteristic	Criteria
Publication type	Clinical studies were included. Emphasis was placed on identifying good quality studies. Abstracts were excluded where no clinical outcomes were reported, or where the paper was a review, editorial, or a laboratory or animal study. Conference abstracts were also excluded because of the difficulty of appraising study methodology, unless they reported specific adverse events that were not available in the published literature.
Patient	Patients with Achilles tendinopathy.
Intervention/test	Extracorporeal shockwave therapy (ESWT).
Outcome	Articles were retrieved if the abstract contained information relevant to the safety and/or efficacy.
Language	Non-English-language articles were excluded unless they were thought to add substantively to the English-language evidence base.

List of studies included in the IP overview

This IP overview is based on 821 patients from 2 systematic reviews, 1 randomised controlled trial (RCT) and 1 case series[1–5].

Other studies that were considered to be relevant to the procedure but were not included in the main extraction table (table 2) have been listed in appendix A.

Table 2 Summary of key efficacy and safety findings on extracorporeal shockwave therapy for Achilles tendinopathy

Study 1 Mani Babu S (2014)

Details

Study type	**Systematic review and meta-analysis**
Country	UK
Study inclusion period	Search date: inception to February 2013; databases: PubMed (Medline), Embase, Cochrane, CINAHL, Web of Knowledge.
Study population and number	n=**633** patients (from 11 studies in Achilles tendinopathy) 5 RCTs (Costa 2005, Rompe 2007, 2008, 2009, Rasmussen 2008); 2 case-control studies (Furia 2006, 2008) and 4 prospective studies (Lakshmanan 2004, Fridman 2008, Vulpiani 2009, Saxena 2011).
Age and sex	not reported
Study selection criteria	Studies on extracorporeal shockwave therapy (ESWT) for patients with diagnosis of Achilles tendinopathy, greater trochanteric pain syndrome due to gluteal tendinopathy [GTPS] and Patellar tendinopathy, of any study design were included. Animal and non-English studies were excluded.
Technique	ESWT with various treatment protocols delivered.
Follow-up	**short term (<12 months) and long term (>12 months)**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: follow-up periods varied across studies.

Study design issues: Quality assessment was performed by 2 independent reviewers using a modified Downs and Black checklist and level of evidence graded using the van Tulder criteria. Using Review Manager, the effect size calculations were computed and presented in forest plots when sufficient data were provided.

The included studies in this review were heterogeneous with regard to patient selection, indications, treatment protocols (use of a local anaesthetic, energy level, number of impulses, number of treatment sessions, and the interval between treatment sessions), follow-up period and outcome measures. The authors noted that the methodological quality of the studies varied. Studies were limited by small patient numbers, a number of methodological weaknesses, including inadequate randomisation and were considered as having a high risk of bias. Studies used different instruments to measure outcomes. Pain was measured by visual analogue scale (VAS); Patient satisfaction was usually reported using a Likert scale. Functional outcomes and general assessments were measured using VISA-A score, the American orthopaedic foot and ankle society (AOFAS) hindfoot score and Roles Maudsley scores.

Other issues: data on patients for different painful musculoskeletal pathologies treated by ESWT (in greater trochanteric pain syndrome [GTPS] and Patellar Tendinopathy) have not been reported here as it is outside the scope of this overview.

Key efficacy and safety findings

<table>
<tr><td>Efficacy</td><td>Safety: (not reported in the systematic review but taken from the original papers)</td></tr>
<tr><td>Number of patients analysed: 11 studies (5 RCTs, 2 case-control studies, 4 prospective studies)
Non-insertional (mid-portion) Achilles tendinopathy:
<table>
<tr><th>Study</th><th>Design</th><th>Intervention and protocol</th><th>Average follow-up</th><th>Outcome measures</th></tr>
</table>
</td><td>Rompe 2007
There were no serious complications.
All patients had transient</td></tr>
</table>

Rompe 2007	RCT n=75 patients	**ESWT versus eccentric loading versus wait and see approach** **ESWT (radial waves)-** 2000 impulses at 3 bar (0.1mJ/mm2) 8 Hz, no local anaesthesia, 3 sessions (weekly interval) **Eccentric loading**-12 week programme of 3 sets of exercises twice daily, bent and straight knee **Wait and see**- consultation to discuss training modification, stretching exercises, ergonomic advice and medication if needed.	4 months	VISA-A score, general and pain assessment.
Rompe 2009	RCT n=68 patients	**low energy ESWT + eccentric loading exercises versus eccentric loading exercises** **ESWT (radial waves)+ eccentric loading exercises** -after 4 weeks of exercises, ESWT 2000 impulses at 3 bar (0.1 mJ/mm2) 8 Hz; no local anaesthesia, 3 sessions (weekly interval) **Eccentric loading-**12 week programme of 3 sets of exercises twice daily, bent and straight knee	4 months	VISA-A score, general and pain assessment.
Furia 2008	Case control study n=68 patients	**high energy ESWT versus control (Ankle block with or without sedation)** **ESWT (focused waves)-**3000 impulses for a total energy flux density of 604 mJ/mm2; 50 shocks were given at each power level from 1-4 for a total of 200 shocks; the final 2800 shocks were given at power level 5, which corresponds to 0.21 mJ/mm2 1 session **Control-** traditional non-operative therapy	12 months	VAS score and RM score at 1, 3, and 12 months
Lakshmanan and O'Doherty 2004	Prospective study n=15 patients (16 tendons)	**ESWT** 2000 impulses at 2.5 bar 6-10 Hz, no local anaesthesia. 3 sessions (weekly interval)	20.7 months (range, 20-22 months)	VISA-A score and AOFAS score

Pain and functional outcomes

Outcomes	ESWT		Control/Alternative		SMD IV, Fixed, 95% CI
Pain at <12 months (VAS score)	**Mean±SD**	**Total**	**Mean±SD**	**Total**	
1 month					
Furia 2008 ESWT vs Cons	4.4± 0.9	34	7.1± 0.9	34	-2.97 [-3.67, -2.27]
3 month					
Furia 2008 ESWT vs Cons	2.9 ±1.2	34	6.5 ± 0.6	34	-3.75 [-4.56, -2.95]
4 month					
Rompe 2007 ESWT vs Ec	4± 2.2	25	3.6± 2.3	25	0.17 [-0.38, 0.73]
Rompe 2007 ESWT vs Wait	4± 2.2	25	5.9 ±1.8	25	-0.93 [-1.52, -0.34]
Rompe 2009 EcSW vs Ec	2.1± 1.1	34	2.9± 1.8	34	-0.53 [-1.01, -0.05]
Pain at >12 months (VAS score)					
Furia 2008 ESWT vs Cons	2.2±1.2	34	5.6±0.7	34	-3.42 [-4.18, -2.66]
VISA-A score					
Rompe 2007 ESWT vs Ec	-70.4± 16.3	25	-75.6± 18.7	25	0.29 [-0.27, 0.85]
Rompe 2007 ESWT vs Wait	-70.4± 16.3	25	-55± 12.9	25	-1.03 [-1.62, -0.44]
Rompe 2009 EcSW vs Ec	-86.5± 16	34	-73± 19	34	-0.76 [-1.25, -0.27]

reddening of the skin after ESWT.

Patients reported calf ache after eccentric loading.

Costa 2005

During the study, 2 patients in the treatment group had tendon Achilles rupture within 2 weeks of their first treatment. 1 patient fell down a step at home and the other fell while stepping out of an ambulance. Both chose non-operative treatment; 1 patient had complete resolution of symptoms and the other had persistent pain.

The majority of patients (equal numbers in both groups) reported calf ache 48 hours after treatment.

Furia 2008

Complications: 3

2 patients had pain during treatment that resolved after the procedure.

1 patient had transitory reddening of the skin that resolved spontaneously.

Furia 2006

Complications: 5

2 patients had pain during treatment that resolved after the procedure.

2 patients had transitory reddening of the skin that resolved spontaneously.

1 patient had transitory numbness on the

1 Month Roles and Maudsley Score	Events	Total	Events	Total	Risk Ratio M-H, Fixed, 95% CI
Furia 2008 ESWT vs Cons	10	34	27	34	0.37 [0.21, 0.64]
3 Month Roles and Maudsley Score					
Furia 2008 ESWT vs Cons	5	34	25	34	0.20 [0.09, 0.46]
>12 months Roles and Maudsley Score					
Furia 2008 ESWT vs Cons	5	34	25	34	0.20 [0.09, 0.46]
Likert Scale (1-6)					
Rompe 2007 ESWT vs Ec	12	25	10	25	1.20 [0.64, 2.25]
Rompe 2007 ESWT vs Wait	12	25	19	25	0.63 [0.40, 1.00]
Rompe 2009 EcSW vs Ec	6	34	15	34	0.40 [0.18, 0.91]

plantar aspect of the heel that resolved spontaneously within 24 hours.

Insertional Achilles tendinopathy:

Study	Design	Intervention and protocol	Average follow-up	Outcome measures
Rompe 2008	RCT n=50 patients	**low energy ESWT versus eccentric loading exercises** **ESWT (radial waves)-**2000 impulses at 2.5 bar (0.12 mJ/mm2) at 8Hz; no local anaesthesia, 3 sessions (weekly interval) **Eccentric loading exercises** done twice a day for 12 weeks	4 months	VISA-A score, general and pain assessment.
Furia 2006	Case Control n=68 patients	**ESWT versus control** **ESWT focused waves**-3000 impulses for a total energy flux density of 604 mJ/mm2; 50 shocks were given at each power level from 1-4 for a total of 200 shocks; the final 2800 shocks were given at power level 5, which corresponds to 0.21 mJ/mm2; session **Control**-non-specified traditional treatment	12 months	VAS score and RM score at 1, 3, and 12 months after treatment.

Pain and functional outcomes

Outcomes	ESWT		Control/Alternative		SMD IV, Fixed, 95% CI
Pain at <12 months (VAS score)	**Mean±SD**	**Total**	**Mean±SD**	**Total**	
1 month					
Furia 2006 ESWT vs Cons	4.2± 2.4	35	8.2± 1.1	33	-2.10 [-2.70, -1.50]
3 month					
Furia 2006 ESWT vs Cons	2.9± 2.1	35	7.2± 1.3	33	-2.42 [-3.05, -1.78]
4 month					
Rompe 2008 ESWT vs Ec	3±2.3	25	5±2.3	25	-0.86 [-1.44, -0.27]
Pain at >12 months (VAS score)					
Furia 2006 ESWT vs Cons	2.8±2	35	7±1.4	33	-2.39 [-3.02, -1.76]
VISA-A					
Rompe 2008 ESWT vs Ec	-79.4± 10.4	25	63.4± 10	25	-1.54 [-2.18, -0.91]
1 Month Roles and Maudsley Score	**Events**	**Total**	**Events**	**Total**	**Risk Ratio M-H, Fixed, 95% CI**
Furia 2006 ESWT vs Cons	22	35	21	33	0.99 [0.69, 1.42]
3 Month Roles and Maudsley Score					
Furia 2006 ESWT vs Cons	6	35	20	33	0.28 [0.13, 0.62]
>12 months Roles and Maudsley Score					

Furia 2006 ESWT vs Cons	6	35	20	33	0.28 [0.13, 0.62]
Likert Scale (1-6)					
Rompe 2008 ESWT vs Ec	9	25	18	25	0.50 [0.28, 0.89]

Non-insertional (mid-portion) and insertional Achilles tendinopathy:

Study	Design	Intervention and protocol	Average follow-up	Outcome measures
Costa 2005	RCT n=49 patients	**low energy ESWT versus placebo ESWT** **ESWT-**1500 impulses (maximum, 0.2 mJ/mm2), no local anaesthesia 3 sessions (monthly interval) **Placebo-** protocol as ESWT but bubble wrap in a cloth is inserted between tendon and machine	3 months	VAS score, Functional Index of Lower Limb Activity, and EQoL score
Rasmussen 2008	RCT n=48 patients	**low energy ESWT+ conservative therapy versus placebo ESWT + conservative therapy** **ESWT (radial waves)-**2000 impulses (0.12-0.51 mJ/mm2) at 50 Hz, no local anaesthesia 4 sessions; 1-2 weeks between sessions **Placebo-**as per ESWT group but 2000 impulses at 0mJ/mm2, 50 Hz.	3 months	VAS score and AOFAS score
Fridman 2008	Prospective study n=23 patients	**ESWT focused waves** under intravenous sedation and local anaesthesia, 2000 impulses (21 kV) at 2 Hz, 1 session	20 months (range, 4-35 months)	VAS score
Vulpiani 2009	Prospective study n=127 tendons (84 insertional, 43 mid-portion)	**low energy ESWT-** 1500-2500 impulses (mid-portion: 0.08-0.33 mJ/mm2; insertional: 0.12-0.40 mJ/mm2) Average of 4 sessions (between 3-5) 2- to 7-day interval	24 months	VAS score
Saxena 2011	Prospective study n=60 patients (74 tendons - 23 mid-portion, 19 insertional, 32 other)	**low energy ESWT (radial waves):** 2500 impulses at 2.4 bar at 11-13 Hz, no local anaesthesia 3 sessions; 4- to 10-day interval	12-24 months	Roles and Maudsley score

Pain and functional outcomes

Outcomes	ESWT		Control/Alternative		SMD IV, Fixed, 95% CI
Pain at <12 months	**Mean±SD**	**Total**	**Mean±SD**	**Total**	
3 month VAS score					
Costa 2005 ESWT vs P	34.5± 34.2	22	50.3± 36.3	27	-0.44 [-1.01, 0.13]
Functional Index of Lower Limb Activity (FILA)					
Costa 2005 ESWT vs P	-0.95± 0.96	22	-0.24± 0.24	27	-1.05 [-1.65, -0.45]
Euro Quality of Life (EQoL)					
Costa 2005 ESWT vs P	-1.55± 35	22	4.23± 20	27	-0.21 [-0.77, 0.36]
American Orthopaedic Foot and Ankle Society (AOFAS) score					
Rasmussen 2008 ESWT vs P	-88± 10	24	-81± 16	24	-0.52 [-1.09, 0.06]

4 prospective studies across all subgroups reported significant improvements in pain and functional outcomes after ESWT treatment (Firdman 2008, Lakshmanan 2004, Saxena 2011, Vulpiani 2009).	
Abbreviations used: AOFAS score, American Orthopaedic Foot and Ankle Society score; Cons, conservative treatment; CI, confidence interval; Ec, eccentric loading, ESWT, combined extracorporeal shockwave therapy; EcSW, combined extracorporeal shockwave therapy and eccentric loading; P, placebo (sham); RCT, Randomised controlled trial; RM, Roles and Maudsley score; SMD, standard mean difference; VAS, visual analogue scale; VISA-A, Victorian Institute of Sport Assessment Questionnaire-Achilles (questionnaire assessing severity of Achilles tendinopathy); Wait, wait and see policy.	

Study 2 Sussmilch-Leitch SP (2012)

Details

Study type	**Systematic review and meta-analysis**
Country	Australia
Study period	Search date: inception to September 2011; databases: 11databases searched.
Study population and number	n=**246** patients (from 5 studies on ESWT for Achilles tendinopathy (AT) 5 RCTs (Costa 2005, Rompe 2007, 2008, 2009, Rasmussen 2008).
Age and sex	Age range 39-58 years; 50-67% were female.
Patient selection criteria	RCTs evaluating at least 1 non-surgical, non-pharmacological intervention for AT reporting at least 1 outcome of pain and altered function, included patients diagnosed by a healthcare or medical practitioner, with no restrictions on duration of symptoms or length of treatment or follow-up period were included. Search limited to English language and full text human studies. Studies were excluded if the results had been reported in previous publications, or included patients with symptoms related with Achilles rupture, rheumatological disease or the use of antibiotics.
Technique	**Interventions:** ESWT alone, ESWT combined with eccentric exercise, ESWT +conservative therapy **Controls:** sham ESWT, eccentric exercise, wait and see approach, sham ESWT+ conservative therapy
Follow-up	**short term (<12 months) and long term (12 months)**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: follow-up periods varied across studies.

Study design issues: Study design developed in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Comprehensive search strategy used, search strategy for Medline adapted for use in other databases, secondary searching was done by reviewing reference lists of eligible papers. All articles were screened by 2 reviewers and any disagreements resolved with the opinion of a third reviewer. A modified Physiotherapy Evidence Database scale was used to assess the methodological quality and risk of bias of included studies. Mean methodological quality of included studies was 11.2(±0.4, range 11 to12).

Only 1 reviewer extracted the data. Sufficient data for effect size calculations were available for all 5 studies. Effect size calculations and meta-analyses were based on fixed and random effects models respectively. In the meta-analyses, only 2 studies were pooled. Interpretation of standardised mean difference (SMD) was conducted as per Hopkins, an effect size of 4.0 was considered to represent a large clinical effect, 2.0 to 4.0 a very large effect, 1.2 to 2.0 a large effect, 0.6 to 1.2 a moderate effect, 0.2 to 0.6 a small effect and 0.0 to 0.2 a trivial effect.

Visual Analogue Scale (VAS) and the Victorian Institute of Sport Assessment-Achilles (VISA-A) questionnaire were the most commonly used tools to measure outcomes. The American orthopaedic foot and ankle society (AOFAS) hindfoot scale and Functional Index of Lower Limb ability (FILLA) were also used.

Population issues: Studies included patients with symptoms ranging from 6 weeks to 12 months. Patients were diagnosed clinically and 3 studies considered ultrasonography as well. 2 studies included patients with mid-portion AT, 1 study had patients with insertional AT and 2 other studies included patients with either mid-portion or insertional AT.

Other issues: Evidence on patients for other different physical therapies other than ESWT has not been reported here as it is outside the scope of this overview.

Key efficacy and safety findings

Efficacy

Number of patients analysed: **5 studies on ESWT for Achilles tendinopathy**

ESWT versus eccentric exercises

Study	Intervention	Sample size	outcome	SMD (95% CI)
Rompe 2007 mid-portion AT	ESWT (for 3 weeks) vs eccentric exercise (12 weeks)	25 vs 25	VISA-A	16 weeks: -0.29 (-0.27 to 0.85)
Rompe 2008 Insertional AT	ESWT (for 3 weeks) vs eccentric exercise (12 weeks)	25 vs 25	VISA-A	16 weeks: -1.40 (-2.03 to -0.78)

Evidence from meta-analysis of data from 2 RCTs (Rompe 2007-patients with mid-portion AT, Rompe 2008-patients with insertional AT) found no significant effects for outcomes of pain and function (VISA-A: -0.55, -2.21 to 1.11) at 16 weeks.

ESWT versus wait and see approach

Study	Intervention	Sample size	outcome	SMD (95% CI)
Rompe 2007 mid-portion AT	ESWT (for 3 weeks) vs wait and see approach (for 12 weeks)	25 vs 25	VISA-A	16 weeks: -1.03 (-1.62 to -0.44)

ESWT + eccentric exercises versus eccentric exercises alone

Study	Intervention	Sample size	outcome	SMD (95% CI)
Rompe 2009 mid-portion AT	ESWT + eccentric exercise vs eccentric exercise alone (both for 12 weeks)	22 vs 27	VISA-A	16 weeks: -0.76 (-1.28 to -0.24)

ESWT versus placebo (sham ESWT)

Study	Intervention	Sample size	outcome	SMD (95% CI)
Costa 2005 Both mid portion and insertional AT	ESWT vs sham ESWT (both for 12 weeks)	22 vs 27	VAS (pain during walking)	12 weeks: -0.44 (-1.01 to 0.130 52 weeks- insufficient data
Rasmussen 2008 Not reported	ESWT+ conservative therapy vs sham ESWT + conservative therapy (both for 4 weeks)	24 vs 24	AOFAS	4 weeks: -0.52 (-1.10 to 0.06) 8 weeks: insufficient data 12 weeks: insufficient data

Abbreviations used: AT, Achilles tendinopathy; CI, confidence interval; AOFAS score, American Orthopaedic Foot and Ankle Society Score; ESWT, extracorporeal shockwave therapy; RCT, Randomised controlled trial; SMD, standardised mean difference; VAS, visual analogue scale; VISA-A, Victorian Institute of Sport Assessment Questionnaire-Achilles (questionnaire assessing severity of Achilles tendinopathy);

Study 3 Notarnicola A (2014)

Details

Study type	**Randomised Controlled Trial**
Country	Italy
Recruitment period	2011-13
Study population and number	n=**60 (30 extracorporeal shockwave therapy [ESWT]** versus **30 Cold air and High Energy Laser Therapy [CHELT]) patients with insertional Achilles tendinopathy**
Age and sex	mean age: 59.5 years ESWT, 57.5 years CHELT; 42% male ESWT versus 45% male CHELT
Patient selection criteria	Patients aged 18 to 80 years, diagnosis of Achilles tendinopathy lasting at least 6 months made on clinical symptoms and tests and a function VAS score >4 were included. Patients with contraindications for CHELT or ESWT, neoplasia or infections of the affected area, history of epilepsy, coagulopathies, cardiac pacemaker, pregnancy or intolerance to cold, those with history of Achilles tendon surgery, steroid injections in the previous 4 weeks, or deformities of the lower limb were excluded.
Technique	Patients placed in prone position with hip and knee extended and the ankle in maximal extension. ESWT administered during 3 sessions at 3-4 day intervals using a Minilith SL 1 electromagnetic generator equipped with in-line ultrasound guidance and emitting 1600 impulses with an EFD ranging from 0.05 to 0.07 mJ/mm^2. Local anaesthesia was not given. CHELT included 3 wavelengths (1064, 810, and 980 nm) together with a follow of cold air at -30^0 (CEHLT therapy, Medtronic Medicale). It included 10 daily sessions of 1200J and 10W of laser therapy. The area of treatment was approximately $10cm^2$. For eye protection, all subjects wore protective dark glasses. Both group of participants performed stretching and eccentric exercises over a 2 month period.
Follow-up	**6 months**
Conflict of interest/source of funding	Not reported

Analysis

Follow-up issues:

Study design issues: Patients randomised according to age and sex (<40 or >40 years), Pain reduction was assessed on a visual analogue scale (0 to 10, 0 indicating no pain and 10 indicating severe pain), functional recovery was assessed using Ankle Hind Foot Scale (100 points, 100=no pain, no limitation and good alignment; 0=severe pain, limitation and misalignment, combines subjective scores of pain and function with objective scores based on physical examination) and patient satisfaction using Roles and Maudsley Score (4 point subjective assessment of pain and limitation of activity; 1=excellent with no symptoms after treatment, 4= poor symptoms identical or worse than pre-treatment). All scores were collected before treatment, at the end of treatment session, and 2 months after treatment.

Population issues: Patients in the 2 groups were homogenous, all subjects were sedentary and 53% of patients were treated on the right side. The place of treatment is same for both groups.

Key efficacy and safety findings

Efficacy

Number of patients analysed: **30 ESWT versus 30 CHELT for insertional Achilles tendinopathy**

Clinical and functional scores

	ESWT	CHELT	T	P value
Visual Analog Scale (VAS)				
Baseline	7±1.2	7±1.0	-0.45	0.32
End of treatment session	4.9±0.9	2.3±1.1	9.5	<0.0001
At 2 months	5.4±2.7	2.4±1.6	5.3	<0.0001
At 6 months	3.3±2.4	1.7±1.0	3.2	0.0011
Ankle Hindfoot Scale				
Baseline	67±20.5	62.5±8.9	1.1	0.14
At 2 months	73±22.9	81.1±9.2	1.8	0.04
At 6 months	76.9±20.2	83±9.1	1.5	0.07
Roles and Maudsley Score				
At 2 months	2.8±0.4	1.7±0.6	8.5	<0.0001
At 6 months	1.5±0.5	1.5±0.5	7.7	<0.0001

At baseline, there were no statistical significant differences between the 2 groups. At follow-up, VAS was significantly better in the CHELT group ($p<0.001$). At 2 months, the CHELT group was significantly better for AFHS and the Roles and Maudsley score ($p<0.05$) and at 6 months for the Roles and Maudsley score ($p<0.001$).

Abbreviations used: AHS, Ankle Hindfoot Scale; CHELT, Cold air and High Energy Laser Therapy; ESWT, extracorporeal shockwave therapy; VAS, visual analogue scale.

Study 4 Carulli C (2015)

Details

Study type	**Case series**
Country	Italy
Recruitment period	2011-13
Study population and number	n=**102 patients affected with Achilles tendinopathy** mean duration of symptoms: 6.7 weeks
Age and sex	mean age 48 years; 55% (56/102) male
Patient selection criteria	Adult patients with a clinical and instrumental diagnosis of Achilles tendinopathy, persistent symptoms for at least 3 months, failure or partial resolution of symptoms after conservative treatments, no recent history of trauma or chronic joint instability or no related surgery were included. Patients with a clinical but not instrumental diagnosis of tendon disease, those who have not tried any conservative approach, inadequate medical or physical treatments were excluded.
Technique	ESWT (with ReflecTron, HMT, 2400 pulses at 0.08-0.33 mJ/mm^2 intensity) delivered –each patient had 3 applications with a monthly interval and followed up at 1, 6 and 12 months after treatment. No local anaesthesia was given before the treatment.
Follow-up	**12 months**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: overall 28 patients were lost to follow-up from the study, but it is not clear how many Achilles tendinopathy patients were lost to follow-up.

Study design issues: retrospective study, outcomes were evaluated by numeric rating scale and the American Orthopaedic Foot and Ankle Society (AOFAS) Score. Pain assessment was conducted by the 11-point numerical rating scale. All patients were treated by 2 orthopaedic surgeons.

Other issues: data on patients for different painful musculoskeletal pathologies treated by ESWT (calcific tendonitis of the shoulder, n=129; and lateral epicondylitis of the elbow, n=80) have not been reported here as it is outside the scope of this overview.

Key efficacy and safety findings

Efficacy

Number of patients analysed: **102 Achilles tendinopathy**

Clinical and functional scores

	Baseline	**1 month**	**6 months**	**12 months**
Pain on Numerical rating scale (NRS)	6.9±1.2 (5-9)	5.3±1.1 (4-8) p<0.001	1.7±0.8 (0-3) p<0.001	0.3±0.5 (0-2) p<0.001
AOFAS	71±5.6 (63-80)	72±3.2 (67-75) p<0.001	77±2.4 (72-84) p<0.001	86±1.9 (82-90) p<0.001

The use of pain related drugs was reported by some patients, with peak utilisation in the first 3 days, once daily.

Safety

Some patients reported the presence of cutaneous bruises after the applications.

Abbreviations used: ESWT, extracorporeal shockwave therapy; AOFAS score, American Orthopaedic Foot and Ankle Society Score.

Study 5 Taylor J (2016)

Details

Study type	**Case series**
Country	UK
Recruitment period	2010-11
Study population and number	n=**56 patients with refractory Achilles tendinopathy** **insertional AT: 36% (20/56), non-insertional AT: 64% (36/56)** mean duration of symptoms: insertional AT, 20 months; non-insertional AT, 42 months
Age and sex	mean age 58 years; 48% (27/56) male
Patient selection criteria	All patients with clinical history and ultrasound evidence of refractory AT for more than 3 months and failed prior conservative treatments were included in the audit.
Technique	ESWT (with Swiss Dolorclast classic machine, 2400 pulses per treatment, frequency 10Hz, pressure1.5 bar-2.5 Bar) delivered – each patient had 3 sessions of low energy radial EWST at weekly intervals.
Follow-up	**2 years**
Conflict of interest/source of funding	None

Analysis

Follow-up issues: 18% (10/56) patients were lost to follow-up (5 patients at 16 weeks and another 5 at 2 years). Only 46 patients (34 non-insertional-AT, 12 insertional-AT) completed 2 years of follow-up.

Study design issues: Audit; outcomes assessed at 6 and 16 weeks and at 2-year follow-up; pain scores assessed on a visual analogue scale (VAS), functional disability at rest and on activity assessed using Victoria Institute of Sport Assessment-Achilles (VISA-A) scale (with a maximum score of 100). Likert satisfaction scores ranging from 1 (completely recovered) to 6 (worse) were also obtained.

Population issues: smaller sample in the insertional AT group and some patients were diagnosed with Hagland deformity and had surgery. Two patients also had steroid injections during follow-up.

Key efficacy and safety findings

Efficacy

Number of patients analysed: **56**

Pain and functional scores

	Insertional AT, n=20		**Non-Insertional AT, n=36**	
Mean VAS scores	**at rest**	**on activity**	**at rest**	**on activity**
Baseline	2.4	6.7	3.6	7
6 weeks	1.9 (p=0.11)	5.5 (p<0.01)	2.4 (p<0.01)	5 (p<0.01)
16 weeks	1.5 (p=0.04)	4.4 (p<0.01)	1.5 (p<0.01)	4 (p<0.01)
2 years	0.8 (p=0.04)	2.8 (p<0.01)	0.9 (p<0.01)	2.18 (p<0.01)
Mean VISA-A score (maximum function 100)				
Baseline	43		40	
6 weeks	51		50	
16 weeks	58		55	
2 years	70 (p=0.0006)		66 (p<0.0001)	

Likert satisfaction scale scores: statistically significant improvements were seen in the non-insertional AT group between 6 and 16 weeks (p=0.054) and 16 weeks and 2 year (p=0.001). There was no significant improvement in the insertional AT group at any follow-up period.

Subgroup analysis by age and chronicity of AT in both groups show that pain scores on activity improved in all age groups. Improvement in VISA-A scores occurred more quickly in those under 60 years and those who had symptoms for less than 48 or 12 months.

Abbreviations used: ESWT, extracorporeal shockwave therapy; VISA-A, Victorian Institute of Sport Assessment Questionnaire-Achilles (questionnaire assessing severity of Achilles tendinopathy).

Efficacy

Pain and function outcomes

Extracorporeal shockwave therapy (ESWT) for non-insertional (mid-portion) Achilles tendinopathy

In a systematic review and meta-analysis on ESWT (n=633), evidence for mid-portion Achilles tendinopathy (tendinopathy 2 to 6cm from the insertion into the calcaneus) was reported from 2 randomised controlled trials (RCTs) of 75 and 68 patients respectively (Rompe 2007, Rompe 2009). The RCT of 75 patients (Rompe 2007) compared ESWT (n=25) with eccentric loading exercise (n=25) and found no significant effects on pain and functional outcomes at 4-month follow-up (Visual analogue scale [VAS] score standard mean difference [SMD] 0.17, 95% confidence interval [CI] -0.38 to 0.73; Victorian institute of sport assessment questionnaire–Achilles [VISA-A] score SMD 0.29, 95% CI -0.27 to 0.85; Likert scale: risk ratio 1.20, 95% CI 0.64 to 2.25). The study also compared ESWT (n=25) with a 'wait and see' group (no-treatment control, n=25) and found moderate significant effects that favour ESWT at 4-month follow-up (VAS score SMD -0.93, 95% CI -1.52 to -0.34; VISA-A score SMD -1.03, 95% CI -1.62 to -0.44; Likert scale risk ratio 0.63, 95% CI 0.40 to 1.00). The RCT of 68 patients (Rompe 2009) comparing combined ESWT and eccentric loading exercise in mid-portion Achilles tendinopathy (n=34) with eccentric loading exercise alone (n=34) produced greater improvement in pain and function at 4-month follow-up (VAS score SMD -0.53, 95% CI -1.01 to -0.05; VISA-A score SMD -0.76, 95% CI -1.25 to -0.27; Likert scale risk ratio 0.40, 95% CI 0.18 to 0.91)[1].

The systematic review also reported evidence from a case-control study of 68 patients (Furia 2008) comparing ESWT (n=34) with conservative treatment including rest, footwear modification, anti-inflammatory medication, and gastrocnemius-soleus stretching and strengthening (n=34) and found that ESWT was significantly better in improving pain and functional outcomes at 3-month follow-up (VAS score SMD -3.75, 95% CI -4.56 to -2.95; Roles and Maudsley score SMD 0.20, 95% CI 0.09 to 0.46) and after follow-up of at least 12 months (VAS score SMD -3.42, 95% CI -4.18 to -2.66; Roles and Maudsley score risk ratio 0.20, 95% CI 0.09 to 0.46). Another prospective study of 15 patients (Lakshmanan2004) on ESWT for mid-portion Achilles tendinopathy reported significant improvement in VISA-A score and American Orthopaedic Foot and Ankle Society (AOFAS) score at a mean follow-up of 20.7 months[1].

ESWT for insertional Achilles tendinopathy

In the systematic review and meta-analysis on ESWT (n=633), evidence for insertional Achilles tendinopathy (tendinopathy up to 2 cm from the insertion into the calcaneus) was reported from 1 RCT of 50 patients (Rompe 2008) comparing ESWT (n=25) to eccentric loading exercise (n=25) and found significant improvement for outcomes of pain and function at 4-month follow-up (VAS score

SMD -0.86, 95% CI -1.44 to -0.27; VISA-A score SMD -1.54, 95% CI -2.18 to -0.91; Likert scale risk ratio 0.50, 95% CI 0.28 to 0.89)[1].

The systematic review also reported evidence from 1 case-control study of 68 patients (Furia 2006) comparing ESWT (n=34) with conservative treatment including rest, footwear modification, anti-inflammatory medication, and gastrocnemius-soleus stretching and strengthening (n=34) which found that ESWT was significantly better in improving pain and functional outcomes at 3-month follow-up (VAS score SMD -2.42, 95% CI -3.05 to -1.78; Roles and Maudsley score SMD 0.28, 95% CI 0.13 to 0.62) and after follow-up of at least 12 months (VAS score SMD -2.39, 95% CI -3.02 to -1.76; Roles and Maudsley score risk ratio 0.28, 95% CI 0.13 to 0.62). The effect of ESWT was diminished when a local anaesthetic was administered before treatment in this study[1].

ESWT for non-insertional (mid-portion) or insertional Achilles tendinopathy

In a systematic review and meta-analysis of 246 patients, evidence from meta-analysis of data from 2 RCTs (Rompe 2007, patients with mid-portion tendinopathy; Rompe 2008, patients with insertional tendinopathy) found no significant effects on pain and functional outcomes at 16-week follow-up (VISA-A score SMD -0.55, 95% CI -2.21 to 1.11).

In the systematic review and meta-analysis on ESWT (n=633), evidence for mid-portion or insertional Achilles tendinopathy was reported from 2 RCTs of 49 and 48 patients respectively (Costa 2005, Ramussen 2008) comparing ESWT with no treatment (placebo). The RCT of 49 patients (Costa 2005) found no significant difference between ESWT (n=22) and sham treatment (n=27) at 3-month follow-up (VAS score SMD -0.44, 95% CI -1.01 to 0.13; Functional index of lower limb activity [FILA] SMD -1.05, 95% CI -1.65 to -0.45; EQ-5D SMD -0.21, 95% CI -0.77 to 0.36).The average age of patients in the ESWT group was 10 years older than those in sham group. The RCT of 48 patients (Rasmussen 2008) used the same intervention as Costa 2005, but a higher energy level and an extra treatment session. It found that patients in the ESWT group had significantly better American orthopaedic foot and ankle society (AOFAS) scores than the sham group at 3-month follow-up (SMD -0.52, 95% CI -1.09 to 0.06)[1,2].

An RCT comparing ESWT with cold air and high energy (CHELT) for Achilles tendinopathy reported that pain (measured on a VAS) reduced significantly in both groups at 1, 2 and 6-month follow-up ($p<0.01$). The difference between the 2 groups was statistically significant in favour of the CHELT group ($p<0.001$). Ankle scores in both groups improved at 1, 2 and 6-month follow-up. The difference between the groups was statistically better at 2-month follow-up in the CHELT group ($p=0.04$). The difference between the groups was significantly better for the Roles and Maudsley score at follow up of 2 months ($p<0.05$) and 6 months ($p<0.001$) in the CHELT group[3].

The 3 prospective studies on ESWT for mid-portion or insertional Achilles tendinopathy (Firdman 2008, Saxena 2011, Vulpiani 2009) included in the systematic review reported improvements in pain and functional outcomes at an average follow-up of 20 to 24 months[1].

A case series of 102 patients with Achilles tendinopathy treated with ESWT reported improvement in mean pain score (assessed on a 11 point numerical rating scale) from 6.9(±12) at baseline to 0.3(±0.5) at 1-year follow-up ($p<0.001$); and improvement in mean AOFAS score from 71(±5.6) at baseline to 86(±1.9) at 1-year follow-up ($p<0.001$)[3].

A case series of 56 patients with refractory Achilles tendinopathy reported significant improvement in pain (mean VAS scores: insertional AT group 0.8 [$p=0.04$] at rest and 2.8 [$p<0.01$] on activity; non-insertional AT group 0.9 [$p<0.01$] at rest and 2.18 [$p<0.01$] on activity) and function (VISA-A score: non-insertional AT 70 [$p=0.0006$] and insertional AT 66 [$p<0.0001$] at 2-year follow-up. Likert satisfaction scores were significant in the non-insertional AT group but not in the insertional AT group[5].

Safety

Transient skin reddening

Transient skin reddening occurred in all patients treated by extracorporeal shockwave therapy (ESWT) in 1 RCT (Rompe 2007) and in 3 patients each in the 2 case–control studies (Furia 2006 and 2008) included in a systematic review of 11 studies[1].

Some patients reported the presence of cutaneous bruises after the applications of ESWT in the case series of 102 patients with Achilles tendinopathy[3].

Pain

Pain during ESWT in 2 patients and transient numbness for 24 hours after ESWT in 1 patient was reported in a case-control study (Furia 2006) included in the systematic review of 11 studies[1].

Calf ache

Calf ache was reported in some patients who had eccentric loading exercise in 1 RCT (Rompe 2007, numbers not reported), and in an equal number (‘the majority’) of patients in both groups in another RCT (Costa 2005, numbers not reported) included in the systematic review of 11 studies[1].

Achilles tendon rupture

Achilles tendon rupture 2 weeks after the first ESWT treatment session, associated with falls, was reported in 2 patients in 1 RCT (Costa 2005) included in the systematic review of 11 studies[1].

Validity and generalisability of the studies

- Studies included in the systematic reviews in table 2 included a variety of treatment protocols, particularly with respect to the number of shockwaves/impulses applied (treatment doses), the energy density of shockwaves (in bar, mJ/mm2, or kV), equipment used (some produce focal waves, which are more intense and have deeper penetration while others emit radial waves, which are less intense and more superficial), frequency of impulses (in Hz), the number of treatment sessions (ranging from single to 3 or 4 sessions at different intervals), the use of ultrasound guidance, and the use of local anaesthetic.
- Inclusion and exclusion criteria differed across the studies included in the systematic reviews (most studies required a minimum of 6 months duration of symptoms for inclusion; however, 1 study required 3 months and another did not have duration of symptoms inclusion criteria).
- Studies included patients with mid-portion tendinopathy or insertional tendinopathy or both.
- Patients in 2 RCTs included in the systematic review could not be blinded to their treatment group making interpretation of outcomes more difficult.
- There are no studies directly comparing focused ESWT with radial shock wave therapy/radial pulsed therapy (RPT) in the treatment of Achilles tendinopathy.

Existing assessments of this procedure

There were no published assessments from other organisations identified at the time of the literature search.

Related NICE guidance

Below is a list of NICE guidance related to this procedure. Appendix B gives details of the recommendations made in each piece of guidance listed.

Interventional procedures

- Extracorporeal shockwave therapy for refractory Achilles tendinopathy. NICE interventional procedure guidance 312 (2009) Available from http://www.nice.org.uk/guidance/IPG312
- Extracorporeal shockwave therapy for refractory tennis elbow. NICE interventional procedure guidance 313 (2009) Available from http://www.nice.org.uk/guidance/IPG313
- Extracorporeal shockwave therapy for refractory plantar fasciitis. NICE interventional procedure guidance 311 (2009) Available from http://www.nice.org.uk/guidance/IPG311
- Extracorporeal shockwave therapy for Peyronie's disease. NICE interventional procedure guidance 29 (2003) Available from http://www.nice.org.uk/guidance/IPG29
- Extra-corporeal shockwave lithotripsy for calcific tendonitis (tendinopathy) of the shoulder. NICE interventional procedure guidance 21 (2003) Available from http://www.nice.org.uk/guidance/IPG21

Specialist advisers' opinions

Specialist advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College. The advice received is their individual opinion and is not intended to represent the view of the society. The advice provided by Specialist Advisers, in the form of the completed questionnaires, is normally published in full on the NICE website during public consultation, except in circumstances but not limited to, where comments are considered voluminous, or publication would be unlawful or inappropriate. 8 Specialist Advisor Questionnaires for extracorporeal shockwave therapy for Achilles tendinopathy were submitted and can be found on the NICE website.

Patient commentators' opinions

NICE's Public Involvement Programme sent 60 questionnaires to 3 NHS trusts for distribution to patients who had the procedure (or their carers). NICE received 12 completed questionnaires.

The patient commentators' views on the procedure were consistent with the published evidence and the opinions of the specialist advisers.

Issues for consideration by IPAC

- No significant safety concerns were reported.
- It has been suggested that the use of local anaesthesia and/or nerve block may affect outcomes (i.e. interferes with identifying target area for ESWT).

References

1. Mani-Babu S, Morrissey D et al (2015). The effectiveness of extracorporeal shock wave therapy in lower limb tendinopathy: a systematic review. American Journal of Sports Medicine 43 (3) 752-761.
2. Sussmilch-Leitch SP, Collins NJ et al (2012). Physical therapies for Achilles tendinopathy: systematic review and meta-analysis Journal of Foot & Ankle Research 5 (1) 15.
3. Notarnicola A, Maccagnano G et al (2014). CHELT therapy in the treatment of chronic insertional Achilles tendinopathy. Lasers in Medical Science 29 (3) 1217-1225.
4. Carulli C, Tonelli F et al (2015). Effectiveness of extracorporeal shockwave therapy in three major tendon diseases. J Orthop Traumatol.
5. Taylor J, Dunkerley S, Silver D et al (2016). Extracorporeal shockwave therapy (ESWT) for refractory Achilles tendinopathy: A prospective audit with 2-year follow up. Foot 26, 23-29.

Appendix A: Additional papers on extracorporeal shockwave therapy for Achilles tendinopathy

The following table outlines the studies that are considered potentially relevant to the IP overview but were not included in the main data extraction table (table 2). It is by no means an exhaustive list of potentially relevant studies.

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Al-Abbad H and Simon JV (2013). The effectiveness of extracorporeal shock wave therapy on chronic achilles tendinopathy: a systematic review. [Review]. Foot & Ankle International 34 (1) 33-41.	Systematic review on the effectiveness of ESWT in the treatment of insertional and non-insertional Achilles tendinopathies. 4 RCTs and 2 pre-post studies were included.	There was consistent evidence from 4 reviewed studies on the effectiveness of ESWT in the management of patients with chronic Achilles tendinopathies at a minimum 3 months' follow-up. However, combining ESWT with eccentric loading appears to show superior results.	More recent systematic review by Mani Babu (2014) included in table 2. Results in this review were not stratified according insertional or non-insertional Achilles tendinopathies.
Furia JP (2006). High energy extracorporeal shock wave therapy as a treatment for insertional achilles tendinopathy. Am J Sports Med, 34 (5), 733-40.	Case –control study n=35 treated with 1 dose of high energy ESWT versus 33 treated with nonoperative therapy. Follow-up12 months	ESWT is an effective treatment for chronic Achilles tendinopathy. Local field block anaesthesia may decrease the effectiveness of this procedure. Mean VAS scores for control and ESWT groups were 7.0 and 2.8 (p<.001) at 12 months. Roles and Maudsley scores were statistically greater in the ESWT group compared with control group (p>.0002). The mean VAS in the LA group was significantly lower than in the non-LA group (16.77 vs 53.95, p<.001).	Study already included in the systematic review (Mani Babu 2014) included in table 2.
Foldager CB, Kearney C et al (2012). Clinical application of extracorporeal shock wave therapy in orthopaedics: focused versus unfocused shock waves. Ultra-sound Med Biol; 38(10): 1673-80.	Review of clinical studies in Achilles tendinopathy and plantar fasciitis	Aim of the review is to investigate differences in outcome in select orthopaedic applications using focused and unfocused shock waves. AT-unfocused and focused ESWT were shown to have a significant benefit of treating insertional and non-insertional AT. The total TED in the studies was within a narrow range of 600-720 mJ/mm2, except in the study by Rasmussen 2008, in which the variation in EFD was high among the study subjects. No specific differences in the outcomes of focused versus unfocused SWT for AT was seen.	Studies included in this review are included in the systematic review included in table 2.

Gerdesmeyer L, Mittermayr R et al (2015). Current evidence of extracorporeal shock wave therapy in chronic Achilles tendinopathy. International Journal of Surgery. Part B.24 pp 154-159.	Review	Extracorporeal shock wave therapy (ESWT) has been successfully used in soft-tissue pathologies like lateral epicondylitis, plantar fasciitis, tendinopathy of the shoulder and also in bone and skin disorders. Conclusive evidence recommending ESWT as a treatment for Achilles tendinopathy is still lacking. This article analysis the evidence-based literature of ESWT in chronic Achilles tendinopathy. Recently published data have shown the efficacy of focused and radial extracorporeal shock wave therapy.	Review
Kearney R, Costa ML (2010). Insertional Achilles tendinopathy management: a systematic review. Foot Ankle Int. 31 (8):689-94.	Systematic review on the effectiveness of different treatments for insertional tendinopathy of the Achilles. Interventions included decompression of the retrocalcaneal bursa and the superior calcaneal tuberosity, surgical reconstruction, eccentric training programme, debridement with no/partial detachment of the tendon, shock wave therapy, retrocalcaneal decompression, sclerosing therapy and a central tendon splitting approach. Where comparative treatments were evaluated, these included shockwave therapy, debridement with complete detachment and standard practice (non-operative management).	The authors concluded that conservative treatment for insertional tendinopathy of the Achilles favoured eccentric loading and shock wave therapy, but there was limited evidence to assess their effectiveness. The effectiveness of operational interventions remained inconclusive. There was a lack of detailed information on study results and no statistical comparisons; the authors' conclusions seem to reflect the limitations of the evidence.	Review included various surgical and non-surgical treatments for insertional Achilles tendinopathy.

Kertzman P, Lenza M et al (2015). Shockwave treatment for musculoskeletal diseases and bone consolidation: qualitative analysis of the literature. Revista Brasileira de Ortopedia 50 (1) 3-8.	Qualitative analysis on the effectiveness of shockwave treatment among patients with musculoskeletal pathological conditions and pseudoarthrosis.	39 studies were found. Their results varied greatly, as did the types of protocol used. The studies that evaluated the effectiveness of shockwave treatment for lateral epicondylitis, shoulder tendinopathy, knee osteoarthrosis, femoral head osteonecrosis and trochanteric bursitis reported inconsistent results for most of their patients. Those that evaluated patients with calcifying tendinopathy, plantar fasciitis, Achilles tendinopathy, patellar tendinopathy and pseudoarthrosis showed benefits. Shockwave treatment is a safe and non-invasive method for chronic cases in which conventional techniques have been unsatisfactory and should be used in association with other treatment methods for tendinopathy.	Extracorporeal shockwave therapy for many conditions reviewed here. Achilles tendinopathy is one condition.
Langer PR (2015). Two emerging technologies for Achilles tendinopathy and plantar fasciopathy. [Review]. Clinics in Podiatric Medicine & Surgery 32 (2) 183-193.	Review - extracorporeal shock wave therapy and ultrasound-guided percutaneous tenotomy/fasciotomy are discussed	Achilles Tendinopathy: in an RCT by Rasmussen (2008) improved function scores were reported in the group treated with ESWT, stretching and eccentric exercises compared with sham treatment, stretching and eccentric exercises at 8 and 12 weeks follow-up. In another RCT, radial shock waves and eccentric loading provided faster symptom relief compared with ESWT alone but no difference was seen at 1 year follow-up (Rompe 2009). Magnussen (2009) in a systematic review concluded that more research is needed. Foldager (2012) found that ESWT showed a significant benefit for both insertional and non-insertional AT. Saxena et al (2011) showed reduced pain and improved function 1 year after treatment with ESWT.	General review.

Lin TC, Lin TY et al (2012). Achilles tendon tear following shock wave therapy for calcific tendinopathy of the Achilles tendon: a case report. Physical Therapy in Sport 13 (3) 189-192.	Case report n=1 Achilles tendon rupture after ESWT. Follow-up: 2 months	A 49-year-old female was treated with a calcaneal osteotomy due to Haglund's disease on the right. However, she developed chronic calcific Achilles tendinopathy postoperatively, and during the following 2 year period after surgery she received various non-steroidal anti-inflammatory drugs and 1 injection of corticosteroids. She was subsequently treated with extracorporeal shock wave therapy (ESWT), but persistent pain, local swelling and redness over posterior right ankle were noted. Oral analgesics TENS treatment and ultrasound were given. Two months after ESWT radiograph of the right ankle revealed an Achilles tendon tear. The patient received right Achilles tendon reconstruction and post-operative long leg cast. She eventually regained functional recovery of her ankle after an intensive rehabilitation program.	Safety event already reported in a study included in the systematic review added to table 2 (Costa 2005)
Loppini M and Maffulli N (2011). Conservative management of tendinopathy: an evidence-based approach. Muscles, Ligaments and Tendons Journal 1 (4) 134-137.2011.	Several conservative treatment options reviewed.	Eccentric exercises provide excellent clinical results both in athletic and sedentary patients, with no reported adverse effects. Combining eccentric loading and low-energy shock wave therapy produces higher success rates compared with eccentric training alone or shock wave therapy alone. High-volume injection of normal saline solution, corticosteroids, or anaesthetics can reduce pain and improve long-term function in patients with Achilles or patellar tendinopathy. The use of injectable substances such as platelet-rich plasma, autologous blood, polidocanol, and corticosteroids in and around tendons is not support by strong clinical evidence. Further randomized controlled trials are necessary to define the best conservative management of tendinopathy. AT-low energy ESWT or eccentric training for AT showed comparable results in an RCT and both management modalities produced outcomes superior to no intervention (Rompe 2007). The association of eccentric loading and repetitive low energy ESWT is more effective than eccentric loading alone (Rompe 2009).	Review – Several conservative treatment options reviewed and ESWT is one of the therapies.

Maffulli G, Hemmings S et al (2014). Assessment of the Effectiveness of Extracorporeal Shock Wave Therapy (ESWT) For Soft Tissue Injuries (ASSERT): An Online Database Protocol. Translational Medicine @ Unisa 10 46-51.	UK database protocol for the Assessment of Effectiveness of Extracorporeal Shock Wave Therapy for Soft Tissue Injuries and tendinopathies (ASSERT)		Protocol only.
Management of chronic achilles tendinopathy. Drug and Therapeutics Bulletin.50 (8) 93-96, 2012.	Management options for patients with chronic Achilles tendinopathy (lasting over 6 weeks) were assessed.	There is limited evidence of benefit for many treatments. In sports related tendinopathy, the first line treatment should be physical therapy, through a programme of eccentric exercises. There is insufficient evidence to recommend other conservative management options. In patients who fail to improve, surgery may be considered. Minimal invasive techniques may be associated with decreased peri-operative morbidity compared with open surgery. **ESWT:** A systematic review (Magnussen 2010) showed that ESWT was superior to wait and see and equivalent to eccentric exercises in 1 RCT (ROMPE 2007) but not superior to placebo in another (Costa 2005). In another RCT, 50 people with chronic AT received ESWT or eccentric muscle training (Rompe 2009). At 4 months the outcomes improved with ESWT than eccentric exercises. Unwanted effects include transient reddening of the skin.	General review on conservative management options that include eccentric (lengthening) exercises, extracorporeal shockwave therapy (ESWT), topical nitroglycerin, low level laser therapy, orthoses, splints or injections (e.g. corticosteroids, hyperosmolar dextrose, polidocanol, platelet-rich plasma), surgery (using open, percutaneous or endoscopic methods).

Magnussen RA, Dunn WR et al (2009). Nonoperative treatment of mid-portion Achilles tendinopathy: a systematic review. Clin J Sport Med. 19(1):54-64	Systematic review of nonoperative treatment of mid-portion Achilles tendinopathy (including ESWT). 16 RCTs included.	Eccentric exercises were equivalent to extracorporeal shockwave therapy (1 study) and superior to wait-and-see treatment (2 trials), traditional concentric exercise (2 of 3 trials), and night splints (1 study). Extracorporeal shockwave therapy was shown to be superior to a wait-and-see method in 1 study but not superior to placebo in another STUDY. Sclerosing injections were shown to be superior to placebo in 1 study, but local steroid treatment was beneficial in 2 of 3 studies. Injection of deproteinised haemodialysate and topical glyceryl nitrate application were beneficial in 1 trial each.	Review evaluated non-surgical interventions included ESWT for non-insertional AT. Studies on ESWT from this systematic review are already included in the systematic review by Mani Babu (2014) in table 2.
Roche AJ and Calder JD (2013). Achilles tendinopathy: A review of the current concepts of treatment. [Review]. Bone & Joint Journal 95-B (10) 1299-1307.	Review of evidence on insertional and non-insertional Achilles tendinopathy.	The majority of patients with non-insertional tendinopathy will respond to non-surgical management. Rest is useful in acute phase and eccentric exercise in more chronic phase. Injections and shockwave therapy may have a role. In 20-30% who do not respond, surgery may be necessary.	General review.
Rompe JD, Furia J et al (2009). Eccentric loading versus eccentric loading plus shock-wave treatment for mid-portion achilles tendinopathy: a randomized controlled trial. Am J Sports Med. 2009 Mar; 37(3):463-70.	Randomised Controlled trial n=68 patients with a chronic recalcitrant (>6 months) non-insertional Achilles tendinopathy. Group1: 34 eccentric loading versus Group2 : 34eccentric loading plus repetitive low-energy shock-wave therapy Follow-up: 4 months and 1 year.	At 4 months from baseline, the VISA-A score increased in both groups, from 50 to 73 points in group 1 (eccentric loading) and from 51 to 87 points in group 2 (eccentric loading plus shock-wave treatment). Pain rating decreased in both groups, from 7 to 4 points in group 1 and from 7 to 2 points in group 2. 19/34 patients in group 1 (56%) and 28/34 patients in group 2 (82%) reported a Likert scale of 1 or 2 points ("completely recovered" or "much improved"). For all outcome measures, groups 1 and 2 differed significantly in favor of the combined approach at the 4-month follow-up. At 1 year from baseline, there was no difference any longer, with 15 failed patients of group 1 opting for having the combined therapy as cross-over and with 6 failed patients of group 2 having undergone surgery.	Study already included in a systematic review (Mani Babu 2014) included in table 2.

Rowe V, Hemmings S et al (2012). Conservative management of mid-portion Achilles tendinopathy: a mixed methods study, integrating systematic review and clinical reasoning. [Review]. Sports Medicine 42 (11) 941-967.	Mixed methods study Review of literature-systematic review and clinical reasoning	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 trinitrate. The authors suggested that due to the cost of ESWT, physiotherapists felt it may be considered as an inappropriate treatment for AT, with eccentric exercises being the most effective. It may be used for athletic patients.	Recent systematic review (Mani-babu 2015) included in table 2.
Speed, C (2014). A systematic review of shockwave therapies in soft tissue conditions: focusing on the evidence. [Review]. British Journal of Sports Medicine 48 (21) 1538-1542.	Systematic review on shockwave therapies on pain in specific soft tissue injuries. Both focused extracorporeal shockwave therapy (F-ESWT) and radial pulse therapy (RPT) were examined.	23 studies were identified. There is evidence for the benefit of focused ESWT (F-ESWT) and of radial pulse therapy (RPT) in a number of soft tissue musculoskeletal conditions, and evidence that both treatment modalities are safe. There is evidence that F-ESWT is effective in the treatment of plantar fasciitis, calcific tendinitis, and that RPT is effective in plantar fasciitis. Where benefit is seen in F-ESWT, it appears to be dose dependent, with greater success seen with higher dose regimes. There is low level evidence for lack of benefit of low-dose F-ESWT and RPT in non-calcific rotator cuff disease and mixed evidence in lateral epicondylitis. **Achilles tendinopathy** The evidence for F-ESWT and RPT in both mid-portion and insertional ATs is currently very limited. There are no high quality studies of large populations. Studies of RPT do not satisfy the criteria for this review as they are unblinded and uncontrolled (Rompe 2007, 2008, Furia 2006). There is evidence of benefit with high energy F-ESWT in mid-portion disease from 1 small RCT (Costa 2005).and lack of benefit of low dose F-ESWT from 1 small double blinded RCT (Rasmussen 2008).	Use of shockwave therapies for many soft tissue conditions was reviewed. Studies on AT already included in a systematic review (Mani Babu 2014) included in table 2.

Saxena A, Ramdath S et al (2011). Extra-corporeal pulsed-activated therapy ('EPAT' sound wave) for Achilles tendinopathy: a prospective study. J Foot Ankle Surg 50 (3):315-9.	Case series n=74 tendons in 60 patients (including 32 (43.24%) paratendinoses, 23 (31.08%) proximal tendinoses, and 19 (25.68%) insertional tendinosis) Follow-up: 12-24 months	No adverse effects were observed. The Roles and Maudsley Scores improved from 3.22 to 1.84 ($p<0.0001$) in the paratendinosis group and 3.9 to 1.57 ($p<0.0001$) in the proximal tendinopathy group and 3.32 to 1.47 ($p<0.0001$) in the insertional tendinopathy group.	Included in systematic review (Mani Babu S 2014) included in table 2.
Wiegerinck JI, Kerkhoffs GM et al (2013). Treatment for insertional Achilles tendinopathy: a systematic review. [Review]. Knee Surgery, Sports Traumatology, Arthroscopy 21 (6) 1345-1355.	Systematic review to identify surgical and non-surgical therapeutic studies reporting on ten or more adults with insertional Achilles tendinopathy.(1945-2011)	14 trials met our inclusion criteria evaluating 452 procedures in 433 patients. Five surgical techniques were evaluated; all had a good patient satisfaction (avg. 89 %). The complication ratio differed substantially between techniques. Two studies analysed injections showing significant decrease in visual analogue scale (VAS). Eccentric exercises showed a significant decrease in VAS, but a large group of patients was unsatisfied. Extracorporeal shockwave therapy (ESWT) was superior to both wait-and-see and an eccentric training regime. A low medium energy ESWT was given without anaesthesia. One study evaluated laser CO2, TECAR and cryo-ultrasound, all with significant decrease in VAS.	Systematic review included both surgical and non-surgical treatments for insertional Achilles tendinopathy. Studies reporting ESWT, 1 RCT and 1 prospective study (Rompee 2009 and Furia 2005) done by the same group are already included in the systematic review included in table 2.

Zwiers R, Wiegerinck JI et al (2014). Treatment of mid-portion Achilles tendinopathy: an evidence-based overview. Knee Surg Sports Traumatol.Arthrosc.	Review of surgical and non-surgical treatments for mid portion AT.	In Achilles tendinopathy, differentiation should be made between paratendinopathy, insertional- and mid-portion Achilles tendinopathy. Mid-portion Achilles tendinopathy is clinically characterized by a combination of pain and swelling at the affected site, with impaired performance as an important consequence. The treatment of mid-portion Achilles tendinopathy contains both non-surgical and surgical options. Eccentric exercise has shown to be an effective treatment modality. Promising results are demonstrated for extracorporeal shockwave therapy. In terms of the surgical treatment of mid-portion Achilles tendinopathy, no definite recommendations can be made. **ESWT-** An RCT showed that ESWT with eccentric loading showed superior results compared with eccentric loading alone (Rompe 2009).other studies have shown beneficial effects of ESWT in women, and improved outcome after previous non-surgical therapy had failed (Furia 2008, Mani-babu 2014).	Different non-surgical and surgical treatments reviewed.

Appendix B: Related NICE guidance for extracorporeal shockwave therapy for Achilles tendinopathy

Guidance	Recommendations
Interventional procedures	**Extracorporeal shockwave therapy for refractory Achilles tendinopathy. NICE interventional procedure guidance 312 (2009)** 1.1 The evidence on extracorporeal shockwave therapy (ESWT) for refractory Achilles tendinopathy raises no major safety concerns: there have been reports of occasional tendon rupture in treated patients, but this may also occur when the procedure has not been used. However, current evidence on efficacy of the procedure is inconsistent. Therefore, ESWT for refractory Achilles tendinopathy should only be used with special arrangements for clinical governance, consent and audit or research. 1.2 Clinicians wishing to undertake ESWT for refractory Achilles tendinopathy should take the following actions. • Inform the clinical governance leads in their Trusts. • Ensure that patients understand the uncertainty about the procedure's efficacy, and about its safety in relation to a possible risk of tendon rupture, and provide them with clear written information. In addition, the use of NICE's information for patients ('Understanding NICE guidance') is recommended. • Audit and review clinical outcomes of all patients having ESWT for refractory Achilles tendinopathy (see section 3.1). 1.3 NICE encourages further research into ESWT for refractory Achilles tendinopathy. Future research should take the form of clinical studies with clearly described patient selection and treatment protocols, including a description of local anaesthesia use and the type of energy applied (see section 2.5). The studies should include validated outcome measures and be based on a minimum of 1-year follow-up. NICE may review the procedure on publication of further evidence. **Extracorporeal shockwave therapy for refractory tennis elbow. NICE interventional procedure guidance 313 (2009)** 1.1 The evidence on extracorporeal shockwave therapy (ESWT) for refractory tennis elbow raises no major safety concerns; however, current evidence on its efficacy is inconsistent. Therefore, this procedure should only be used with special arrangements for clinical governance, consent and audit or research. 1.2 Clinicians wishing to undertake ESWT for refractory tennis elbow should take the following actions. • Inform the clinical governance leads in their Trusts.

- Ensure that patients understand the uncertainty about the procedure's efficacy and provide them with clear written information. In addition, the use of NICE's information for patients ('Understanding NICE guidance') is recommended.
- Audit and review clinical outcomes of all patients having ESWT for refractory tennis elbow (see section 3.1).

1.3 NICE encourages further research into ESWT for refractory tennis elbow. Future research should take the form of clinical studies with clearly described patient selection and treatment protocols, including a description of local anaesthesia use and the type of energy applied (see section 2.5). The studies should include validated outcome measures and be based on a minimum of 1-year follow-up. NICE may review the procedure on publication of further evidence.

Extracorporeal shockwave therapy for refractory plantar fasciitis. NICE interventional procedure guidance 311 (2009)

1.1 The evidence on extracorporeal shockwave therapy (ESWT) for refractory plantar fasciitis raises no major safety concerns; however, current evidence on its efficacy is inconsistent. Therefore, this procedure should only be used with special arrangements for clinical governance, consent and audit or research.

1.2 Clinicians wishing to undertake ESWT for refractory plantar fasciitis should take the following actions.

- Inform the clinical governance leads in their Trusts.
- Ensure that patients understand the uncertainty about the procedure's efficacy and provide them with clear written information. In addition, the use of NICE's information for patients ('Understanding NICE guidance') is recommended.
- Audit and review clinical outcomes of all patients having ESWT for refractory plantar fasciitis (see section 3.1).

1.3 NICE encourages further research into ESWT for refractory plantar fasciitis. Future research should take the form of clinical studies with clearly described patient selection and treatment protocols, including a description of local anaesthesia use and the type of energy applied (see section 2.5). The studies should include validated outcome measures and be based on a minimum of 1-year follow-up. NICE may review the procedure on publication of further evidence.

Extracorporeal shockwave therapy for refractory plantar fasciitis. NICE interventional procedure guidance 311 (2009)

1.1 The evidence on extracorporeal shockwave therapy (ESWT) for refractory plantar fasciitis raises no major safety concerns; however, current evidence on its efficacy is inconsistent. Therefore, this procedure should only be used with special arrangements for clinical governance, consent and audit or research.

1.2 Clinicians wishing to undertake ESWT for refractory plantar fasciitis should take the following actions.

- Inform the clinical governance leads in their Trusts.
- Ensure that patients understand the uncertainty about the procedure's efficacy and provide them with clear written information. In addition, the use of NICE's information for patients ('Understanding NICE guidance') is recommended.
- Audit and review clinical outcomes of all patients having ESWT for refractory plantar fasciitis (see section 3.1).

1.3 NICE encourages further research into ESWT for refractory plantar fasciitis. Future research should take the form of clinical studies with clearly described patient selection and treatment protocols, including a description of local anaesthesia use and the type of energy applied (see section 2.5). The studies should include validated outcome measures and be based on a minimum of 1-year follow-up. NICE may review the procedure on publication of further evidence.

Extracorporeal shockwave therapy for Peyronie's disease. NICE interventional procedure guidance 29 (2003)

1.1 Current evidence on the safety of extracorporeal shockwave therapy (ESWT) for Peyronie's disease appears adequate. However, the evidence on the efficacy does not appear adequate to support the use of this procedure without special arrangements for consent and for audit or research. Clinicians wishing to undertake ESWT for Peyronie's disease should inform the clinical governance leads in their Trusts. They should ensure that patients offered the procedure understand the uncertainty about its efficacy and should provide them with clear written information. Use of the Institute's information for the public is recommended. Clinicians should ensure appropriate arrangements are in place for audit or research. Publication of efficacy outcomes will be useful in reducing the current uncertainty. NICE is not undertaking further investigation at present.

	Extra-corporeal shockwave lithotripsy for calcific tendonitis (tendinopathy) of the shoulder. NICE interventional procedure guidance 21 (2003) 1.1 Current evidence on the safety and efficacy of extracorporeal shockwave lithotripsy for calcific tendonitis of the shoulder appears adequate to support the use of the procedure, provided that normal arrangements are in place for consent, audit and clinical governance

Appendix C: Literature search for extracorporeal shockwave therapy for Achilles tendinopathy

Databases	Date searched	Version/files
Cochrane Database of Systematic Reviews – CDSR (Cochrane Library)	26/05/2016	Issue 5 of 12, May 2016
Cochrane Central Database of Controlled Trials – CENTRAL (Cochrane Library)	26/05/2016	Issue 4 of 12, April 2016
HTA database (Cochrane Library)	26/05/2016	Issue 2 of 4, April 2016
MEDLINE (Ovid)	26/05/2016	1946 to May Week 3 2016
MEDLINE In-Process (Ovid)	26/05/2016	May 25, 2016
EMBASE (Ovid)	26/05/2016	1974 to 2016 Week 21
PubMed	26/05/2016	n/a
JournalTOCS	26/05/2016	n/a

1 High-Energy Shock Waves/

2 (Shockwave* or Shock-wave* or (shock* adj1 wave*)).tw.

3 ESWT.tw.

4 or/1-3

5 Achilles Tendon/

6 achill*.tw.

7 or/5-6

8 Tendinopathy/

9 Tendon Injuries/

10 Tendinopath*.tw.

11 (tendin* or tendon*).tw.

12 or/8-11

13 7 and 12

14 Achillodynia*.tw.

15 13 or 14

16 4 and 15

17 animals/ not humans/

18 16 not 17

19 limit 18 to ed=20120222-20160526