HOW AND WHERE TO USE EXTRACORPOREAL SHOCKWAVE THERAPY

There is a growing evidence base demonstrating that extracorporeal shockwave therapy (ESWT) is beneficial for the treatment of musculoskeletal conditions, reducing pain and promoting tissue healing in the short term. It is a non-invasive therapy and is of particular interest as it may well allow your client to continue with the training/competing demands of the season. This article provides the most up-to-date information about the indications and contraindications for ESWT, the evidence base for its use and what protocols have been used. This information will allow you to determine if ESWT will benefit your client and how to begin to use it for their condition.
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Extracorporeal shockwave therapy (ESWT), also referred to simply as shockwave therapy (SWT), is used to treat a range of musculoskeletal conditions. Technically, there are two types of ESWT: focused SWT and radial SWT (which uses radial pressure waves). Some may view them as distinctly different therapeutic modalities; however, despite their differences (in physical characteristics, method of energy generation and shockwave propagation), both types of ESWT share common clinical indications. Historically, ESWT was indicated as a secondary conservative treatment choice for recalcitrant musculoskeletal conditions, unresponsive to standard care (1,2*). This may include conditions such as plantar fasciitis, Achilles tendinopathy, patellar tendinopathy, calcific and non-calcific shoulder tendinopathy, and lateral epicondylitis (3*). Bone- and cartilage-related disorders, such as non-union of fractures, osteonecrosis of the femoral head and knee-osteoarthritis-related bone marrow oedema, may also be included in the range of clinical indications for ESWT. As ESWT reduces pain and promotes tissue healing and has shown greater efficacy in the short term over the long term, it seems clear that ESWT should be used as a primary conservative treatment option, rather than merely a secondary tool.

EXTRACORPOREAL SHOCKWAVE THERAPY (ESWT) IS USED TO TREAT A RANGE OF MUSCULOSKELETAL CONDITIONS

Clinicians may find this tool useful to treat musculoskeletal conditions, particularly as the body of evidence supporting its efficacy grows. ESWT parameters – type of shockwave, number of impulses, energy flux density (EFD), area of application, number/frequency/duration of treatment session, use of analgesia – can be adjusted depending on the condition and patient's tolerance. Optimal evidence-based, standardised treatment protocols specific to given conditions are yet to be determined owing to the heterogeneity across clinical trial methodology. This article aims to highlight areas of research supporting the clinical use of ESWT to treat musculoskeletal conditions.

For an interesting and in-depth discussion about the use of ESWT, listen to the podcast by Physiotutors with leading UK shockwave therapist Paul Hobrough (https://paulhobrough.com/): Podcast 022 Paul Hobrough shockwave (https://www.youtube.com/watch?v=nq7zk027nSg).

How the EWST Works

1. Types of Shockwave

Shockwaves are a form of energy that develop a peak pressure up to approximately 1000 times higher than that of ultrasound. Two primary forms of ESWT are used in clinical practice: focused shockwave and radial shockwave (4*).

Focused shockwaves are generated through three mechanisms:

electrohydraulic, piezoelectric or electromagnetic methods that convert electrical energy into kinetic energy. They produce a higher maximal energy level and a deeper maximal force. The higher energy can be a more painful treatment application.

Radial shockwaves are generated pneumatically. They produce a lower maximal energy level, with its peak force absorbed by superficial structures attenuating the energy at greater depths. The lower energy can be a less painful treatment application.

2. Mechanism of ESWT

The mechanisms of ESWT are not completely understood, but shockwaves are thought to have a mechanical (mechano-transduction) and cellular effect that enhances tissue regeneration, healing and alters pain signalling (Tables 1 & 2). Mechanical stimuli – referred to as cellular mechano-transduction, or mechanotherapy – explain how cellular migration, proliferation, differentiation and apoptosis occur as a result of ESWT. Apart from a purely mechanical stimulus, the higher energy levels transmitted through the tissues may result in disruptive shear stresses that affect calcifications. Cellular changes, induced by pain modulation, can be explained by the principle of hyperstimulation analgesia (5*,6*,7*).

Myofascial pain syndrome (MPS), is a common musculoskeletal syndrome characterised by muscle stiffness, pain, taut intramuscular bands, local twitch response, and hyperirritable muscle fibres or myofascial trigger points. The energy crisis hypothesis may explain the effects of ESWT, whereby increasing perfusion of damaged ischemic tissues, increasing vascularisation and changing pain stimuli in ischemic tissues may improve symptoms of pain, fatigue, sleep, depression and quality of life (9*). Although many theories have been proposed, the exact mechanism of action of ESWT still remains to be elucidated.

3. ESWT Parameters

With each ESWT treatment, there are several parameters that can be adjusted. In a clinical environment,

Table 1: Proposed cellular mechanisms of action for extracorporeal shockwave therapy (ESWT) Tenforde AS, Borgstrom HE, DeLuca S et al. Best practices for extracorporeal shockwave therapy in musculoskeletal medicine: clinical application and training consideration. PM & R 2022;14:611–619 8, https://bit.ly/3QubzNW. Reproduced under Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

Effect	Mechanism of action
Increased collagen synthesis	● Enhanced fibroblast proliferation (increased transforming growth factor beta [TGF-ß]) and upregulation of collagen I and III ● Regulation of scleraxis, tenomodulin
Cellular proliferation and wound healing	● Upregulation of tendon-derived tenocytes ● Increased ATP release and downstream extracellular signal-regulated kinase activation ● Enhancement of osteogenesis ● IL-6 and IL-8 mediated tendon remodelling
Pain reduction	● Gate-control theory ● Modifies substance P release ● Decreased calcitonin-gene-related peptide
Neovascularisation	● Induction of TGF-ßI and insulin-like growth factor I
Decrease in soft tissue calcifications	
Decrease in inflammation	

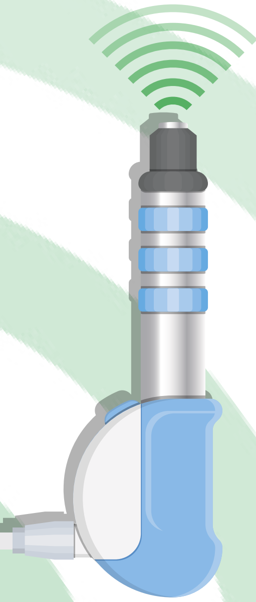
Table 2: Specific postulated mechanisms of action of ESWT
Tenforde AS, Borgstrom HE, DeLuca S et al. Best practices for extracorporeal shockwave therapy in musculoskeletal medicine: clinical application and training consideration. PM & R 2022;14:611–619 8, https://bit.ly/3QubzNW. Reproduced under Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

Pathology	Mechanism of action
Tendons	● Decreased oedema and inflammatory cell infiltration within tendons ● Tissue regeneration via conversion of mechanical stimulation to biochemical signal ● Increase transforming growth factor beta-1 and insulin-like growth factor I levels to stimulate tenocyte and collagen proliferation (important in healing) ● Scleraxis upregulation (promotes tendon growth and development) ○ Proliferation of anti-inflammatory cytokines ○ Increased proliferation and migration of tendon-derived tenocytes ○ Decreased metalloproteinase expression (enzymes that can degrade collagen) ○ Reduction of inflammatory interleukins
Bones	● Protein upregulation may enhance angiogenesis and neovascularisation of the bone ● Osteogenesis and bone remodelling by release of growth factors ○ Bone morphogenic protein 2 ○ Vascular endothelial growth factor ● Promotion of periosteal bone formation ○ Decreased osteoclast activity ○ Increased osteoblast activity
Joints (knee)	● Decreased inflammation ● Decreased oedema ● Improvements in subchondral bone architecture ● Increased chondrocyte activity (cartilaginous repair)
Spasticity	● Decreased spasticity at the level of the muscle and neuromuscular junction ● Reduced rigidity of connective tissues (muscle level) ● Stimulate synthesis of nitric oxide ○ Neuromuscular junction formation ○ Neovascularisation

●● OPTIMAL, EVIDENCE-BASED, STANDARDISED TREATMENT PROTOCOLS SPECIFIC TO GIVEN CONDITIONS ARE YET TO BE DETERMINED ●●

machine settings should be recorded with each treatment. Optimal protocols vary by indication, and there are few accepted 'routine' settings. The parameter most commonly adjusted with ESWT application is EFD, which is defined as the energy per impulse at the focal point of a shockwave. In focused ESWT, EFD is often reported in mJ·mm^2 and for radial ESWT in bar (for comparison, typical measures of radial shockwave 2 bar is approximately 0.09mJ·mm^2 and 4 bar is approximately 0.18mJ·mm^2) (4*). Even within focused ESWT devices, the EFD can vary; for example, the EFD of an electrohydraulic device does not equate to that of a piezoelectric device.

When assessing the effectiveness of ESWT and translating clinical trials into practice the type of wave (focused or radial), EFD, number of impulses, number of treatment sessions, days between sessions, area of application, use of coupling gel, and use of analgesia during application should all be considered. See Table 2 in Shroeder A et al. (https://bit.ly/3A2yJUF) for a summary of the available evidence and clinical recommendations/practice for the different ESWT parameters (4*). Multiple head-to-head studies have been conducted comparing the effectiveness of focused versus radial SWT for conditions including tendinopathy and spasticity. It is apparent from the results that both forms of SWT are appropriate; however, owing to the mechanistic differences outcomes may differ across given conditions (10,11*,12*).



Where To Use ESWT

The physiologic effects of shockwaves have been widely investigated, and observations have been made on how the different energy forms can affect the musculoskeletal system, reducing pain and facilitating tissue healing. The beneficial effects from a clinical perspective have been shown across a variety of clinical trials in the management of musculoskeletal disorders.

The International Society for Medical Shockwave Treatment (13*,14*) has outlined numerous indications for the use of ESWT. It is a non-invasive option with minimal side effects that may allow an individual to continue participating in their sport or activity, pain permitting, while receiving a course of treatment. This may be preferable to more-invasive treatment options, such as corticosteroid injections, tenotomy, and platelet-rich plasma injections, which carry the risk of tendon rupture or require variable amounts of time away from sport or activity (4*).

Indications for the use of ESWT in musculoskeletal conditions include:

1. Tendon pathologies
   - 1.1 rotator cuff tendinopathy
   - 1.2 lateral epicondylopathy of the elbow
   - 1.3 greater trochanteric pain syndrome
   - 1.4 hamstring tendinopathy
   - 1.5 patellar tendinopathy
   - 1.6 Achilles tendinopathy
   - 1.7 plantar fasciopathy
   - 1.8 adductor tendinopathy
   - 1.9 pes anserine tendinopathy
   - 1.10 peroneal tendinopathy
   - 1.11 distal biceps tendinopathy
2. Bone pathologies
   - 2.1 delayed healing/non-union
   - 2.2 stress fracture
   - 2.3 Osgood–Schlatter disease
   - 2.4 medial tibial stress syndrome
   - 2.5 bone marrow oedema
   - 2.6 avascular necrosis
   - 2.7 osteochondritis dissecans
3. Muscle pathologies
   - 3.1 myofascial pain
   - 3.2 muscle strain without discontinuity
4. Joint pathologies
5. Management of spasticity (13*,14*).

1. Clinical Application in Tendinopathies, Fasciopathy and Soft Tissue Pathologies

The most frequently studied application of ESWT is of chronic tendinopathies and plantar fasciitis. Both focused and radial ESWT have proven clinical efficacy. Combining forms of focused and radial ESWT in clinical practice may be an effective option, targeting different anatomical structures within a given musculoskeletal condition (8*,11*,15,16,17*).

It is recommended that treatment should be performed without the use of anaesthetics. Clinical focusing – that being described as treatment directed over the area of maximal pain – should be used to optimise treatment outcomes and guide application from primary to secondary injury sites. ESWT should not only be applied to the primary site of tendon pathology but should include the muscle–tendon–bone unit thus addressing soft tissue impairments that could be contributing to the condition. For example, midportion Achilles tendinopathy treatment should include direct application over the painful portion of the tendon as well as exploration of painful sites in the soleus, gastrocnemius, myotendinous junction and the calcaneal enthesis. An upper limit in total treatment application has not been established, thus identifying and treating secondary injury sites can also be performed during a single treatment session. Bear in mind that ESWT can be painful and this should be accounted for during treatment and when counselling patients (8*).

1.1 Rotator Cuff Tendinopathy (Calcific and Non-Calcific)

- A recent Cochrane review and meta-analysis of over 32 clinical trials comparing ESWT to placebo, compared high-dose ESWT to low-dose ESWT or compared ESWT with various other interventions for treatment of rotator cuff disease (calcific and non-calcific tendinopathy) concluded that (i) ESWT compared with placebo at 3 months showed improvements in pain and function; however, (ii) these measures did not meet the minimum clinically important difference in the ESWT group (18*). Wide clinical diversity and varying treatment protocols make comparison challenging and question whether some trials tested subtherapeutic doses, possibly underestimating any potential benefits.

- A recent study showed significantly greater improvement in pain and function in the focused (electromagnetic) ESWT group (four sessions, EFD 0.09±0.018mJ·mm^2, impulse #3000) to radial ESWT (four sessions, EFD 4±0.35 bar, impulse #3000) at 24 and 48 weeks, despite both groups improving from baseline (12*).
- Positioning the shoulder in hyperextension and internal rotation during focused ESWT treatment (three weekly sessions, EFD 0.22mJ·mm^2, impulse #1200) resulted in significantly more reabsorption of calcific deposits. More studies are needed to determine the use of ESWT in reabsorption of calcific deposits, to see if the size, density and location of the calcific deposit matter and whether the appearance of calcific deposits on imaging is of clinical relevance (4*).
- ESWT appears to be safe with minimal adverse events, although the optimum treatment parameters are not known for rotator cuff tendinopathy.

1.2. Lateral Elbow Epicondylopathy (4*)

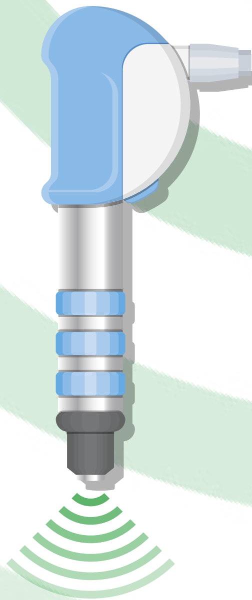
- Studies show mixed treatment efficacy.
- Studies comparing ESWT to placebo, ultrasound, laser and lower-dose ESWT have shown improvements in pain and grip strength in the short term (1 to 3 months), but no difference in overall function.
- ESWT over the lateral epicondyle is not always tolerated due to pain. It is recommended that energy levels be adjusted to maintain a tolerable pain level. The EFD and frequency can be slowly titrated up as tolerated. One can consider use of a softer applicator, such as a plastic tip or silicon tip for radial ESWT.

1.3. Greater Trochanteric Pain Syndrome (GTPS) (4*)

- Both radial and focused ESWT may be efficacious in treating GTPS.
- Radial ESWT (one session, four bars, impulse #2000) for GTPS has shown improved short-term (3 months) and long-term (12 months) outcomes compared with baseline, with 76% of athletes returning to sport within 1 week to 3 months.
- Similarly, when compared to corticosteroid injection radial ESWT (three sessions, three bars, impulse #2000) showed greater long-term (15 months) efficacy.
- Studies using focused ESWT (three weekly sessions, EFD 0.20mJ·mm^2, impulse #2000; or three weekly sessions, EFD 0.15mJ·mm^2, impulse #1800) resulted in improved pain and function at 2 and 6 months.
- Considering the typical depth of the gluteal tendons (varying across patients), the use of high-energy focused ESWT may be preferred to achieve adequate EFD at the site of deeper penetration.

1.4. Proximal Hamstring Tendinopathy

- There are only a handful of randomised controlled trials on the use of ESWT to treat proximal hamstring tendinopathy; however, success has been reported.
- Cacchio et al. (19) compared conservative management [non-steroidal anti-inflammatory drugs (NSAIDs), physical therapy, and an exercise programme] to radial ESWT (four weekly sessions, EFD 0.18mJ·mm^2, impulse #2500) for the treatment of proximal hamstring tendinopathy in professional athletes. A significant improvement in pain and function was reported at 3 months in the ESWT group. Of the ESWT group 85%, compared to only 10% of the conservative group, reported at least a 50% reduction in pain. Dramatically, 80% of athletes treated with ESWT returned to their preinjury level of sports participation by 3 months, whereas 0% of those in the conservative treatment group returned to sport at 3 months.
- Similarly, treatment of proximal hamstring tendinopathy in runners has shown radial ESWT (average, four sessions, EFD 2 to 5 bar) successful in 69% of cases achieving minimal clinically important difference in the measured functional outcome (20).
- As a result of the success of these clinical trials, the conditions used have become a well established ESWT protocol: four sessions of radial ESWT with EFD of 0.18mJ·mm^2. However, more sessions can be performed if needed, and EFD can be adjusted according to the patient's tolerance of the treatment.



1.5. Patellar Tendinopathy

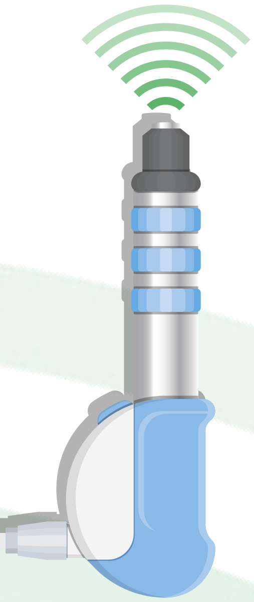
- Studies have used focused and radial ESWT with varied protocols.
- A meta-analysis concluded that ESWT may be a superior alternative to other non-operative treatments (physical therapy, NSAIDs, exercise) in the short term and equal to patellar tenotomy surgery at up to 24 months (21).
- Cheng et al. (22) performed a randomised controlled trial in athletes with patellar tendinopathy, comparing radial ESWT (16 weekly sessions, EFD 1.5 to 3 bar, impulse #2000) to a control group (who received physical therapy modalities such as acupuncture, ultrasonic wave and microwave therapy) and showed improved pain and strength in both treatment groups at 16 weeks.
- ESWT is an effective non-operative treatment for patellar tendinopathy.
- ESWT may be used safely during the competitive season for athletes with patellar tendinopathy with more immediate gains in pain relief and function (4*).

1.6. Achilles Tendinopathy

- For midportion Achilles

ESWT IS THOUGHT TO HAVE A MECHANICAL AND CELLULAR EFFECT THAT ENHANCES TISSUE REGENERATION, HEALING AND ALTERS PAIN SIGNALLING

ESWT IS A NON-INVASIVE OPTION WITH MINIMAL SIDE EFFECTS THAT MAY ALLOW AN INDIVIDUAL TO CONTINUE PARTICIPATING IN THEIR SPORT OR ACTIVITY DURING THERAPY



tendinopathy, there are multiple trials comparing ESWT to sham and eccentric exercises alone, showing superior results with EST, but without determining an optimal protocol. Protocols using focused ESWT (three sessions every 1 to 2 weeks, EFD 0.12–0.51mJ·mm^2, impulse #2000) showed improvements in pain and functional outcomes at 8 and 12 weeks; whereas focused ESWT (four weekly sessions, EFD 0.25 to 0.4mJ·mm^2, impulse #1500 plus EFD 1.8–2.6mJ·mm^2, impulse #3000) showed improvements only at 16 weeks (4*).

- Chronic midportion Achilles tendinopathy responded better to the combination of radial ESWT (three weekly sessions, EFD 3 bar, impulse #2000) plus eccentric exercises compared to eccentric exercises alone; with improved pain and function at 4 and 12 weeks (23). Further studies have validated the efficacy of combining ESWT with eccentric exercises over a longer follow up (16 months) as well as comparing it to other treatment options (eccentric exercises plus image guided high-volume injection, plus corticosteroids); suggesting that ESWT can be considered a non-invasive, synergistic treatment alternative to eccentric exercises (24*,25,26).
- Insertional Achilles tendinopathy is historically more challenging to treat than midportion tendinopathy. Studies using radial ESWT have shown improved pain and function in the short term at 4 and 12 weeks (4*). However, the most recent meta-analysis concluded that at present, with the limited available controlled trials and small sample size, ESWT treatment may be ineffective for insertional Achilles tendinopathy (27*).
- Thus, Achilles tendinopathy should be managed with eccentric exercises and ESWT added in conjunction to this (27*).
- ESWT may allow for short-term pain relief permitting the patient to better tolerate an eccentric loading programme.

1.7. Plantar Fasciopathy

- The greatest amount of evidence supports ESWT use for this indication.
- Several recent meta-analyses show the superiority of a variety of ESWT protocols to placebo and other treatments (ultrasound, low-level laser, pulsed radiofrequency treatment, and corticosteroid injections) (28,29,30*).
- ESWT may be more efficacious at higher intensity (EFD >0.36mJ·mm^2) in the short term (0–6 weeks) (4*).

Radial ESWT has been shown to be effective in treatment of overuse tendon injuries including distal biceps tendinopathy and tibialis posterior tendinopathy. The limited number of studies on these 'other' tendinopathies show promising results using radial ESWT for reducing pain and improving function in the short term. Combining it with rehabilitation, for example a progressive intrinsic foot muscle exercise regimen for tibialis posterior tendinopathy, has shown significant improvement in function (31).

2. Clinical Application for Bone Stress Injuries, Delayed Union and Avascular Necrosis

Application of high-energy ESWT is required to treat bone-related conditions, as the mechanism to facilitate bone remodelling requires upregulation of localised nitrous oxide to promote angiogenesis (8*). The use of focused ESWT to achieve higher EFD is recommended to target bone-related conditions. This can be accomplished through combining clinical focusing, using existing imaging results (eg. X-rays or scans) or ultrasound-guided application to visualise underlying anatomy and neurovascular structures (8*).

3. Clinical Application for Muscle Pathologies

As a non-invasive and safe modality, the use of ESWT has expanded to the treatment of (MPS). Thus far, a single treatment modality has not been proven to be superior to treat MPS (32*). A study on the impact of the combined effect of ESWT (1.5 bar, 8Hz, and 1,000 shocks/trigger point with one session per week) and integrated neuromuscular inhibition (a combination of ischemic compression, strain/counter-strain and muscle energy technique) on MPS of the upper trapezius showed that while both ESWT and integrated neuromuscular inhibition individually improved pain intensity, pressure pain threshold, functional impairment, sympathetic skin response, and neuromuscular junction response, their combined usage led to more marked effects. This highlights the integrated approach as a better option (33*).

A systematic review and meta-analysis suggest ESWT to be helpful for pain in patients with MPS of the trapezius and could serve as an adjunct therapeutic method to treatments such as dry needling, trigger point injection and laser therapy (32*,34).

As a confirmation of the efficacy of ESWT in cervical myofascial pain control following neck dissection, ESWT administered once a week for 4 weeks (0.25mJ·mm^2, 1,000 shocks) compared to topical NSAID (3 times per day for 4 weeks) provided better pain reduction, with no side effects (35*).

The first report evaluating acute muscle strains and contusions in elite football players showed that integrating radial ESWT (6000–12,000 shockwaves per session of 1.0–3.4 bar, depending on the patient's pain tolerance and increased over subsequent treatment days) into a customised multimodal therapy approach (cryotherapy, compression, manual therapy, resistance/weight-training, a progressive physiotherapy exercise programme) proved safe and effective. The addition of ESWT led to shortened lay-off times and reduced reinjury rates without causing any adverse effects (36*). These are promising new areas for ESWT use that require more research in the future.

4. Clinical Application for Joint Pathology

As with any joint pathology, management may be complex owing to multiple anatomic structures involved. Also, targeting or isolating certain tissues with ESWT may be challenging. Focused ESWT may have a greater impact on ossification and bony pathology within the joint, whereas radial ESWT may preferentially target surrounding soft tissues (such as articular cartilage). Given the presence of multiple anatomic structures within joints as well as the challenges to preferentially target individual structures, combined ESWT may be a more appropriate treatment for joint pathology; however, more research into this treatment option is required (8*).

5. Clinical Applications in the Management of Spasticity

Multiple trials have concluded that ESWT is beneficial in reducing pain, improving range of motion, reducing spasticity and thus improving function in conditions such as cerebral palsy, stroke, spinal cord injury with both upper and lower limb spasticity. Radial ESWT at lower energy levels has frequently been used in these clinical trials; as with other studies of other pathologies there have been multiple differences in devices, frequencies, and doses used (8*).

Within the realm of musculoskeletal injuries and pathology, future trends in ESWT treatment may include spinal cord pathologies. The efficacy of ESWT as an adjunct treatment in these patients is promising. There is evidence of potential benefits with minimal adverse effects across osteoporosis, spinal cord injury, cervical spondylosis, scoliosis, sacroiliitis, coccydynia and chronic lower back pain (37*,38*). Although the use of ESWT for pain management is well established, future research may be able to identify additional benefits in these areas, and to establish the long-term advantages of ESWT.

Counselling the Patient

ESWT has been shown to be relatively safe and well tolerated. The main adverse effects include:

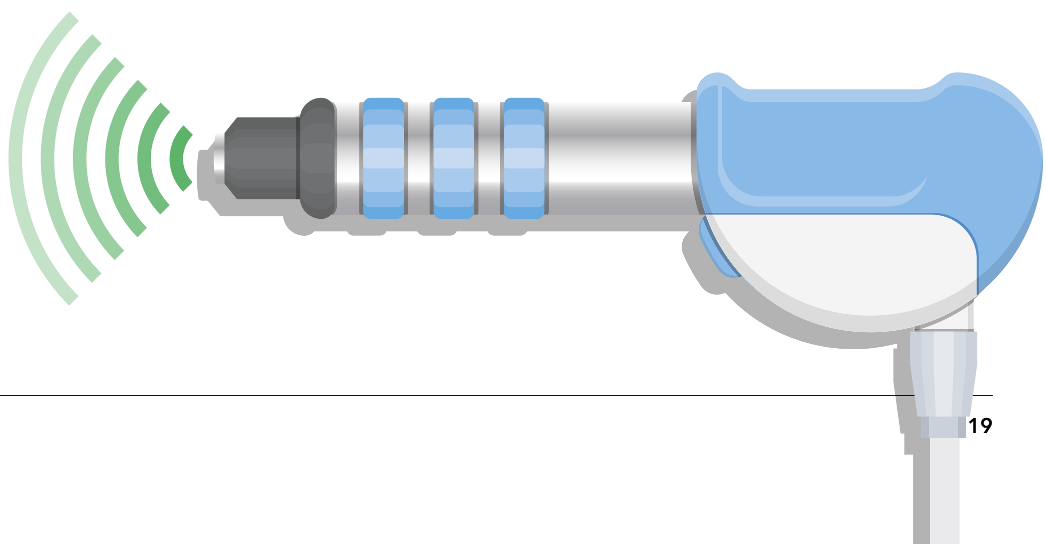
- Local effects – at the site of application
  - pain (primarily during application at the applicator site);
  - skin erythema (transient reddening, swelling);
  - skin bruising;
  - haematoma formation; and
  - nerve irritation (transient numbness or tingling).
- Systemic effects
  - headache; and
  - migraine (6*,13*,14*).

Pain during the treatment is expected, as one treatment goal is to identify sites of pain. Hyperstimulation analgesia may explain why a majority of patients will experience pain relief following the treatment (8*). Tolerability of ESWT should be discussed with patients, as many report it to be an "unpleasant but tolerable" experience. If needed, the EFD can be decreased when patients are not able to tolerate higher energy levels. As with any intervention, patients may not find the relief they desire and their expectations may be unmet, or potentially treatment may worsen their symptoms. The duration of post-procedure pain relief is not directly correlated to overall successful treatment response. Pain in the days following treatment should be managed with acetaminophen or other topical analgesia as needed. Avoiding use of NSAIDs for breakthrough pain relief is critical, as key aspects of the inflammatory cascade may contribute to tissue healing. For all these points mentioned above, counselling before and after treatment is thus essential (6*,8*,39).

It is generally considered that ESWT can be safely used as a treatment option for athletes within the competitive season without necessitating time away from sport. Likewise, studies have indicated that combining ESWT with eccentric loading programmes (and other physical therapy treatments) may produce optimal outcomes for the patient. The level of physical activity following ESWT requires clinical decision-making based on factors including type of shockwave treatment, functional status and condition being managed. Clearly a condition involving bone pathology may require a phase of rest or reduced weight-bearing (crutches or moon boot), whereas a tendon or soft tissue injury may benefit from early progressive loading incorporated into the rehabilitation programme (4*,8*).

Postprocedural recommendations therefore include the following advice or measures:

- Pain may increase slightly on the day of the procedure.
- Patients can often continue activities as tolerated (with pain <3/10), unless a stress fracture or tendon tear is present, and it is anticipated that the injury will progress with continued participation in sport.
- Rest is recommended if possible (depending on sporting or in-season demands).
- ESWT is not a substitute but a supplement for physical therapy.
- Analgesic medication (eg. paracetamol) can be continued as needed, but avoid NSAIDs during



and after treatments.

- ESWT can be given concurrently with other treatment interventions (4*).

The International Society for Medical Shockwave Treatment (ISMST), has compiled a list of contraindications to ESWT:

- Absolute contraindications (all energy treatments)
  - active infection (ie. osteomyelitis);
  - malignant tumour (focused shockwave); and
  - pregnancy.
- Relative contraindications (high-energy treatments)
  - brain or nerve in treatment focus;
  - lung or pleura in treatment focus;
  - significant coagulopathy; and
  - epiphyseal plate in treatment focus.
- Important considerations
  - cardiac pacemakers or other implantable devices;
  - current NSAID use;
  - current anticoagulation use; and
  - recent corticosteroid injections (13*).

Conclusions

ESWT is a safe treatment option for a variety of musculoskeletal conditions. Different physiological mechanisms underpinning ESWT treatment may individually or collectively play a role contributing to the regenerative processes and benefiting a diversity of physical problems. Various protocols have shown efficacy in reducing pain and improving function but no single optimal ESWT protocol has been identified. Across studies and body regions, ESWT appears to be most efficacious in the short term. ESWT is not a substitute for other physical therapy modalities but should be added as a complimentary supplement within a rehabilitation protocol; the goal being to achieve long-term benefits.

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Key Points

- Shockwaves are thought to have a mechanical (mechano-transduction) and cellular effect that enhances tissue regeneration, healing and alters pain signalling.
- ESWT is a non-invasive treatment option with minimal side effects that may allow an individual to continue participating in their sport or activity, pain permitting, while receiving a course of treatment.
- ESWT may be preferable to more-invasive treatment options.
- There are numerous indications for treatment including tendon and bone pathologies, spasticity, joint and muscle injuries.
- ESWT is proven to reduce pain in the short term.
- ESWT should be used as a supplement to physical therapy treatment and rehabilitation and not as a substitute.
- Research has shown better clinical outcomes when ESWT is incorporated into an eccentric loading programme (for Achilles tendinopathy) or when combined with standard therapy (for example manual therapy, exercise therapy, cryotherapy, dry needling, or ultrasound) for musculoskeletal conditions.
- ESWT may be unpleasant but tolerable, as pain is experienced during and/or after treatment, thus counselling a patient about their treatment and expectations is critical.
- The energy flux density (EFD) can be decreased if patients are unable to tolerate higher energy levels due to pain, and titrate up over subsequent treatments.
- Across the varied musculoskeletal conditions, optimal treatment parameters and protocols for ESWT are yet to be fully established.

DISCUSSIONS

- In your experience of treating musculoskeletal pathologies with ESWT, which responded best to this treatment and was it alone or in combination with standard physical therapy?
- What are your greatest complaints or concerns from patients when using ESWT and how do you manage them?
- If you are interested in beginning to use ESWT, which pathologies would you start with and why? How would you decide what treatment protocol to use?

RELATED CONTENT

- Shockwave Therapy Content Marketing Campaign for Physical Therapists https://bit.ly/3pnJOL6

THE AUTHOR

Kathryn Thomas BSc Physio, MPhil Sports Physiotherapy is a physiotherapist with a Master's degree in Sports Physiotherapy from the Institute of Sports Science and University of Cape Town, South Africa. She graduated both her honours and Master's degrees Cum Laude, and with Deans awards. After graduating in 2000 Kathryn worked in sports practices focusing on musculoskeletal injuries and rehabilitation. She was contracted to work with the Dolphins Cricket team (county/provincial team) and The Sharks rugby teams (Super rugby). Kathryn has also worked and supervised physios at the annual Comrades Marathon and Amashova cycle races for many years. She has worked with elite athletes from different sporting disciplines such as hockey, athletics, swimming and tennis. She was a competitive athlete holding national and provincial colours for swimming, biathlon, athletics, and surf lifesaving, and has a passion for sports and exercise physiology. She has presented research at the annual American College of Sports Medicine congress in Baltimore, and at South African Sports Medicine Association in 2000 and 2011. She is Co-Kinetic's technical editor and has taken on responsibility for writing our new clinical review updates for practitioners.

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