Use of extracorporeal shock wave therapy for children's foot, ankle and leg concerns

Extracorporeal Shock wave Therapy (ESWT)

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This position statement was developed in consultation and discussion with the above listed clinicians as part of an international working party. All working party members contributed to gathering, critically evaluating and summarising the evidence. This work was unfunded. The working party considers themselves to be representative of the broad practice areas where this treatment modality may be researched or used.

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Plain English Public Statement

There is a new treatment called ‘shock wave’. It may help people with foot, ankle, or leg conditions. Our team reviewed research about shock wave treatment for foot, ankle, or leg problems. We focused on research about children and teenagers. We assessed the research quality.

Children or teenagers should not have shockwave treatment for foot, ankle, or leg problems

We are taking this position because:

- Successful treatments are those which improve pain, activity and participation.
- Some treatments are not the same for adults and children because of differences during growing
- Treatments which hurt are not always successful or valuable. Shock wave is one treatment that can hurt
- Some shock wave machine instructions tell us not to use it on children and teenagers; other machine instructions say you can use it for some conditions - but you should be careful
- Some podiatrists promote shock wave for children or teenagers even with these warnings
- Best evidence does not support shock wave use in children or teenagers.

Position Statement Summary

- Children and teenagers are vulnerable due to future health being dependent on current health, their behaviours, development, and the overall environmental impact on wellbeing; vulnerability is especially due to their physiological and psychosocial needs
- Foot, ankle or leg conditions in children and teenagers can change body function, participation in care, family, and education settings, or how much activity can be performed compared to children without these conditions
- There are many established high value treatments for children who have pain, body limitations, activity, and participation limitations because of conditions relating to the foot, ankle, and leg
- Interventions that induce pain, or treatments that have a cost implication over that of alternatively effective high-value care, have limited use in health care, particularly in paediatric health care. These treatments are known as low-value care.
- There is increasing interest in the use of extracorporeal shock wave therapy (ESWT) for the treatment of foot, ankle, and leg conditions
- The majority of ESWT equipment technical manuals provide a list of contradictions or warnings that this technology should not be used on children or teenagers with growth plates, with some manufacturers providing condition-based exceptions or cautions.
- Despite these warnings, there is evidence this equipment is being promoted for use in clinical practice with children and teenagers
- A systematic review and risk of bias assessment of evidence relating to the use of ESWT in children informed this position statement. There were very few well-designed clinical trials assessing the efficacy of this treatment
- From the few trials that do exist, our review findings show that ESWT does not offer an advantage over other treatment for any outcomes relating to foot, ankle, or leg pathologies in children or teenagers

- There are unknown harms associated with the use of any technology that may induce a pain response during its use, or have limited, or no benefit compared to no treatment, or a treatment currently embedded in practice
- This means there is no evidence supporting the use of ESWT in children and teenagers' foot, ankle, or leg conditions. These statements are based on the body of evidence using ESWT as a treatment in these age groups and with a variety of health conditions
- Our review also found that where there was evidence for efficacy, it was associated with concerns about the risk of bias. This limits the generalisability of these findings in clinical practice
- Podiatrists intending to use ESWT on children and teenagers, should only do so within the confines of an ethically approved and well-designed clinical trial that also considers comparative effectiveness and cost within its design.

This position statement has been developed to guide podiatrists who may be considering the use of this technology in children and teenagers. This position statement has been informed by the current available evidence, manufacturer guidelines and consensus opinion.

1. Purpose

Childhood is considered a particularly vulnerable time due to physiological and psychosocial needs. This is due to differences in maturity, ability to communicate and comprehend, and a high reliance on adults for support to navigate health care structures. Childhood health has a substantial impact on future health status, behaviours, development, and wellbeing.

Children and teenagers' foot, ankle or leg conditions also have broad impacts. These conditions can change the way their body functions, how they participate in care, family, and education settings, and how much activity they can perform compared to others without these conditions.

There is currently limited advice on the use of ESWT in children and teenagers. At the time of developing this position statement, many manufacturers also provide advice against use of ESWT in children and teenagers.

Therefore, this position statement has been developed to guide the use of ESWT in children and teenagers for podiatrists who have access to ESWT or refer for its use. This statement is informed through a systematic literature review that was prospectively registered (PROSPERO - CRD42022339917, 01/07/2022) and with reference to ESWT manufacturer guidelines. **Appendix 1** provides the PRISMA table of article screening associated with this systematic review. We used the Cochrane risk-of-bias tool for randomized trials (RoB - 2) (1) and the Risk Of Bias In Non-randomised Studies - of Interventions (ROBINS-I) tools to describe risk of bias of included studies (2).

2. Definition of children and teenagers

For this position statement, we group children and teenagers under the term "child" or "children". We have taken this term from the aged-based definition of "child" which is adopted by the "*Convention on the Rights of the Child"* as being persons under the age of 18 years (3). We acknowledge children and teenagers as having unique and specific health needs, however, we have constrained this position statement based on the physiological changes that are consistent in skin and bone during this time.

3. Definition of ESWT

Extracorporeal shock wave therapy is a non-invasive treatment that is increasingly used to manage musculoskeletal conditions, including those in the foot, ankle, and leg. The treatment involves the administration of acoustic sound or 'shock' waves via a probe placed on the skin. The shock waves are thought to pass through tissues, including muscle and bone, to the affected region of interest. The exact mechanism of how shock waves then heal or change the tone of pathological tissue is unclear. It has been suggested that the shock waves cause vibration and mechanical stress in the region, which leads to the growth of new blood vessels and the stimulation of other cells that promote tissue healing (4). Whereas it is still unknown why shock waves can impact tone (5). For this position statement, we have considered either focused and radial extracorporeal shock wave therapy applied to the lower limb, of any dose (single or multiple), and any frequency.

4. Evidence investigating the use of ESWT in foot, ankle or leg conditions in people aged 18 or younger

We found 15 studies that used a variety of types and doses of ESWT during treatment of a foot, ankle or leg problem in children in clinical trials and case reports. We extracted data from these studies and reported the study populations based on the International Classification of Disease – 11 (6) (**Appendix 2**). We grouped outcomes relating to the use of ESWT, based on the domains of the International Classification of Functioning, Disability and Health (7). Using these internationally accepted coding frameworks allowed us to align specific conditions and outcomes of interest. This framework also enabled mapping of the outcomes of treatment with ESWT to either a child's body function and structure, the child's ability to participate in activities of daily living, and any participation limitations. We also planned to extract any impact on the family, such as direct or indirect costs as an additional domain of the ICF.

All studies reported outcomes relating to the foot, ankle or leg function or structure (including pain or other symptoms) (8-22). Two studies reported data relating to activity limitation (17, 21) and one reported data relating to participation (17). No studies provided the cost of treatment to family. Children with spastic diplegia were the most studied population (n=12 of 15 studies) (8-12, 14-16, 18-20, 22).

Appendix 3 provides a graphical display of the risk of bias for included studies.

4.1 Evidence supporting the use of ESWT resulting in a change in the impairment of a body structure or function (including pain) in children

All studies provided results relating to impairment of a body or function. There were two studies providing outcomes relating to a change in pain (17, 21). Both studies were related to the ICD-11 Classification Chapter 15 - Diseases of the musculoskeletal system or connective tissue. These two studies used a case series (n=1) design and had some concerns or serious risk of bias (**Appendix 3**), for a combined participant number of two. Based on these very limited studies, there is no evidence to suggest that ESWT should be used in clinical practice as a treatment modality for pain in children who have foot, ankle, or leg conditions.

There were nine studies investigating change in muscle tone following the use of ESWT (8-11, 15, 16, 19, 20, 22). The design of these studies included six randomised comparative effectiveness trials with ESWT as an additional treatment to a standard treatment in a two - or three-arm trial (8, 9, 15, 19), or comparing differing doses of ESWT (20, 22) two studies that used within-subject quasi-experimental designs (11, 16), one prospective case series (n=1 design) (10), and one retrospective medical chart review (18). Six studies reported a positive change in tone over a limited period of time (<12 weeks)(9, 10, 15, 16, 19, 22), whilst one reported no difference (11), one reported a variable dose dependent response (20) and one omitted tone results (8). All studies investigating change in muscle tone had some concerns about their risk of bias. The research timeframe, limited ability to combine results to understand overall effect and risk of bias, means there is limited support for ESWT as a treatment modality for tone changes in children who have foot, ankle, or leg conditions.

There were six studies investigating change in kinematic gait or foot pressure measures following the use of ESWT (8, 9, 12-14, 16). The design of these studies included five randomised comparative effectiveness trials with ESWT as an additional treatment to a standard treatment in a two-or three-arm trial (8, 9, 12-14) and one within-subject quasi-experimental design (16). Walking speed was the most common variable measured and improved in both study and control groups in one study (9), or only in the intervention group in one study (8) over a limited period of time (<12 weeks). Two studies reported no difference in walking speed compared to the control or alternative treatment (12, 14). Only one study reported foot pressure measures, finding ESWT increased pressure (more foot contact) on the limb with spasticity over a limited period of time (<12 weeks) (16). All studies

investigating change in gait or foot pressure measures had some concerns about their risk of bias. The research timeframe, limited ability to combine results to understand overall effect and risk of bias, means there is limited support for ESWT as a treatment modality for common gait measures or foot pressure measures in children who have foot, ankle, or leg conditions.

There were five studies investigating change in muscle range following the use of ESWT (13, 16, 18, 20, 21). The design of these studies included two randomised comparative effectiveness trials with ESWT as an additional treatment to a standard treatment in a three-arm trial (13) or comparing different doses (20), one retrospective medical chart review (18), one within subject quasi-experimental design (16), and one single case series (21). Three studies reported a positive change in muscle range over a limited period of time (<12 weeks) (16, 18, 21), one reported differences between ESWT to one group's standard treatment, but not the other group's standard treatment in a three-arm trial (13), while another reported range change with differing doses (20). All studies investigating change in muscle range had some concerns about their risk of bias. The timeframe, limited ability to combine results to understand overall effect, study design with confounding treatments, and risk of bias, means there is limited support for ESWT as a treatment modality for muscle range in children with foot, ankle, or leg conditions.

Finally, there were also studies investigating change in motor reflexes (8, 12, 14), power (15), involuntary and control of voluntary movement (12, 15) or alignment of the lower limb (17). There were limited benefits reported across these outcomes over a limited period of time (<12 weeks). Of these, there was one study rated as having serious risk of bias, all others rated as having some concerns. The timeframe, limited ability to combine results to understand overall effect, and risk of bias, means there is limited support for ESWT as a treatment modality for conditions resulting in these different functional outcomes in the foot, ankle, or leg in children.
Although not a focus on this review (due to a lack of reported data), any limited, low quality beneficial effects observed were comparable to, or less than, beneficial effects of other established interventions (e.g., exercise, ankle foot orthoses) reported in the literature. Furthermore, acceptability of treatment to children and their family was not investigated in any study.

4.2 Benefits and limitations of ESWT use for foot, ankle or leg conditions resulting in activity limitation of children

There were two single case series investigating change in activity following the use of ESWT (17, 21). Both studies (combined participants n=2) reported an increase in ability to engage in physical activity. These studies were rated as having some concern or serious risk of bias. However, given these are two single case series, their timeframes and risk of bias, there is limited support for ESWT as a treatment modality to improve activity in children with foot, ankle, or leg conditions.

4.3 Benefits and limitations of ESWT use for foot, ankle or leg conditions resulting in participation difficulties for children

There was a single case series investigating change in participation in activities of daily living following the use of ESWT (17). This participant reported benefits in outcomes of self-care, general interpersonal interactions, choosing appropriate clothing (footwear) and looking after one's health over a limited period of time (<12 weeks). This single case series, with a limited timeframe, and rated as having serious risk of bias means there is no evidence to support ESWT as a treatment modality to improve participation in children with foot, ankle, or leg conditions.

5. Harms, warnings, and precautions to the use of ESWT within research and manufacturer guidelines

It is essential that podiatrists minimise procedure-induced pain in clinical practice for patients of all ages. Pain minimisation is commonly done through reassuring psychological interventions, language, and physiological interventions (e.g., anaesthetics, analgesics) during or after any painful treatment. However, paediatric pain requires a broader lens due to its impact on the family, inability, or limited maturity to rationalise and/or verbalise pain, and reliance on the family for pre- or post-procedural pain relief. Children are also unfortunately treated inequitably with procedural pain due to reliance on others to advocate for their safe and effective care (23). This means every health professional using a procedure that may induce pain should consider a) what is the impact of the condition if left untreated, b) is there evidence of clinically/significantly greater effectiveness of the painful treatment compared to a less painful treatment, and only then, c) is there a way to minimise procedure pain if it is the most effective treatment.

It is accepted that the use of ESWT results in pain over bony areas (24). Therefore, even though some foot, ankle and leg conditions in childhood may have detrimental impacts on the individual, any procedure (or treatment such as ESWT) should be avoided as there is no support effectiveness evidence. This is even when there are ways to minimise pain during treatment.

5.1 Manufacturer guidelines, contraindications, and warnings

Appendix 4 provides a list of ten ESWT machine manufacturer guidelines and the contraindications/precautions relating to children or foot, ankle, and leg conditions known to present over childhood. These machine names were collated from the studies included in this

review (if they are still operating), and additional ESWT machine manufacturers known to the authors (n=10). Most manufacturers provided contraindications or precautions relating to use in children. Two device manufacturers (same brand) provided warnings/cautions against the use of ESWT in children, stating “Never use this device on children, the unconscious or anyone who cannot give verbal consent or warnings about pain”. Of the others, there was diverse listings of contraindications and precautions provided.

A contraindication is a circumstance when something should not be used. Two manufacturers listed “*over or near bone growth centre until bone growth is complete*” as contraindications. Whereas two others indicated either children during growth or children under the age of 18 (except for the treatment of Osgood-Schlatter disease) being contraindicated. Given we did not find any studies investigating ESWT for treatment of Osgood-Schlatter disease, it is unknown why one manufacturer provided an exception for this single condition, particularly without evidence supporting any ESWT effectiveness. Therefore, given there is no evidence of effectiveness for this condition, we recommend against its use in this case.

A precaution is considered as circumstances or conditions which may increase the risk of an adverse reaction. Three manufacturers listed “*children under the age of 18*” as a precaution, while two listed the precaution of “treatment should be applied with caution over bone where minimal (bony prominence) soft tissue is present”. Given most areas of the foot and ankle are near a bony area with minimal soft tissue in children, this indicates many manufacturers concerns about the use of ESWT for foot, ankle, or leg problems in children.

Some manufacturer guidelines also included precautions relating to conditions that are known to present in children under the age of 18 (n=6). Only two machines had no age or condition related precautions in their guidelines.

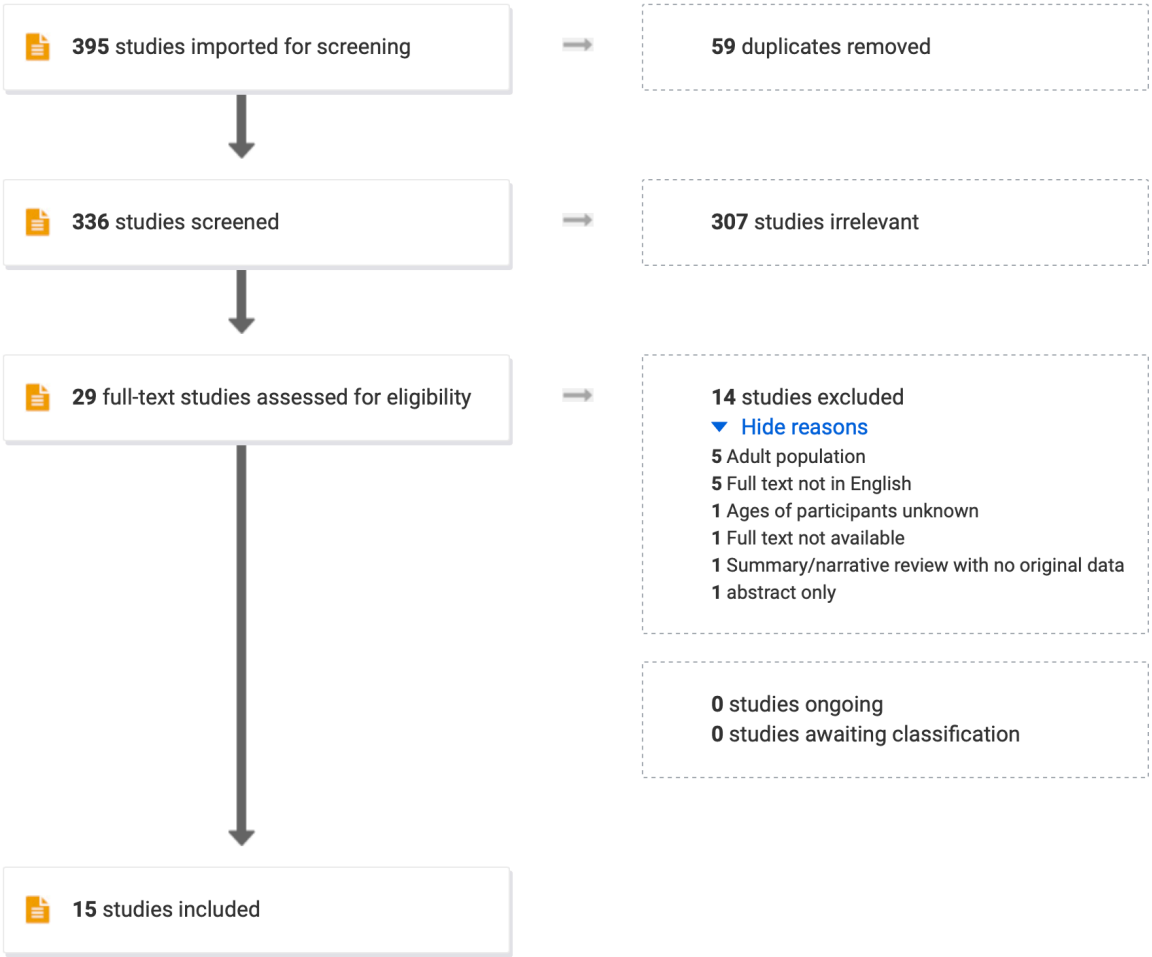
References

1. Higgins JP, Savović J, Page MJ, Elbers RG, Sterne JA. Assessing risk of bias in a randomized trial. Cochrane handbook for systematic reviews of interventions. 2019:205-28.
2. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. bmj. 2016;355.
3. United Nations. Convention on the Rights of the Child: United Nations,; 1989 [Available from: **https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-child.**
4. Wang C-J, Huang H-Y, Pai C-H. Shock wave-enhanced neovascularization at the tendon-bone junction: an experiment in dogs. The journal of foot and ankle surgery. 2002;41(1):16-22.
5. Opara J, Taradaj J, Walewicz K, Rosińczuk J, Dymarek R. The Current State of Knowledge on the Clinical and Methodological Aspects of Extracorporeal Shock Waves Therapy in the Management of Post-Stroke Spasticity—Overview of 20 Years of Experiences. Journal of Clinical Medicine. 2021;10(2):261.
6. World Health Organisation. ICD-11 for Mortality and Morbidity Statistics 2022 [Available from: **https://icd.who.int/browse11/l-m/en.**
7. Simeonsson RJ, Leonardi M, Lollar D, Bjorck-Akesson E, Hollenweger J, Martinuzzi A. Applying the International Classification of Functioning, Disability and Health (ICF) to measure childhood disability. Disability and rehabilitation. 2003;25(11-12):602-10.
8. Abdel Gawad HA, Abdel Karim AE, Mohammed AH. Shock wave therapy for spastic plantar flexor muscles in hemiplegic cerebral palsy children. Egyptian Journal of Medical Human Genetics. 2015;16(3):269-75.
9. Allam HH, Almalki AJ, Elsayyad LK. Effect of shockwave therapy on kinematic gait parameters in children with spastic diplegic cerebral palsy. International Journal of Therapy And Rehabilitation. 2021;28(3):1-10.
10. Altindag O, Gursoy S. Effect of shock wave therapy on spasticity: A single- institution experience. Turkiye Fiziksel Tip ve Rehabilitasyon Dergisi. 2014;60(SUPPL. 1):S95-S6.

11. Amelio E, Manganotti P. Effect of shock wave stimulation on hypertonic plantar flexor muscles in patients with cerebral palsy: A placebo-controlled study. Journal of Rehabilitation Medicine. 2010;42(4):339-43.
12. Elnaggar RK, Abd-Elmonem AM. Effects of Radial Shockwave Therapy and Orthotics Applied with Physical Training on Motor Function of Children with Spastic Diplegia: A Randomized Trial. Physical & occupational therapy in pediatrics. 2019;39(6):692-707.
13. Elnaggar RK, Samhan AF, Elshafey MA. Differential Effects of Extracorporeal Shockwave Therapy and Botulinum Toxin-A Injection on Postburn Contractures and Gait Kinematics in Burn Children. 2020;41(3):612.
14. Elnegamy TE. Impacts of shock wave versus ankle orthosis on spastic calf muscles in hemiparetic children. Int J Ther Rehabil Res. 2017;6(3):27-32.
15. Emara HA, Al-Johani AH, Khaled OA, Ragab WM, Al-Shenqiti AM. Effect of extracorporeal shock wave therapy on spastic equinus foot in children with unilateral cerebral palsy. Journal of Taibah University Medical Sciences. 2022.
16. Gonkova MI, Ilieva EM, Ferriero G, Chavdarov I. Effect of radial shock wave therapy on muscle spasticity in children with cerebral palsy. International journal of rehabilitation research Internationale Zeitschrift fur Rehabilitationsforschung Revue internationale de recherches de readaptation. 2013;36(3):284-90.
17. Ikoma K, Hara Y, Maki M, Ohashi S, Ueshima K, Kubo T. Extracorporeal Shock Wave Therapy for an Adolescent Patient with Calcific Tendinopathy of Posterior Tibial Tendon: A Case Report. Progress in rehabilitation medicine. 2018;3:20180004.
18. Kwon DR, Kwon DG. Botulinum Toxin a Injection Combined with Radial Extracorporeal Shock Wave Therapy in Children with Spastic Cerebral Palsy: Shear Wave Sonoelastographic Findings in the Medial Gastrocnemius Muscle, Preliminary Study. Children (Basel, Switzerland). 2021;8(11).
19. Lin Y, Wang G, Wang B. Rehabilitation treatment of spastic cerebral palsy with radial extracorporeal shock wave therapy and rehabilitation therapy. Medicine (United States). 2018;97(51):e13828.
20. Park D-S, Kwon DR, Park G-Y, Lee MY. Therapeutic Effect of Extracorporeal Shock Wave Therapy According to Treatment Session on Gastrocnemius Muscle Spasticity in Children With Spastic Cerebral Palsy: A Pilot Study. Annals of rehabilitation medicine. 2015;39(6):914-21.

21. Moretti B, Notarnicola A, Moretti L, Giordano P, Patella V. A volleyball player with bilateral knee osteochondritis dissecans treated with extracorporeal shock wave therapy. La Chirurgia degli organi di movimento. 2009;93(1):37-41.
22. Wardhani RK, Wahyuni LK, Laksmitasari B, Lakmudin A. Effect of session frequency of radial extracorporeal shockwave therapy on gastrocnemius muscle spasticity in children with spastic cerebral palsy: a double-blinded, randomised clinical trial. International Journal of Therapy And Rehabilitation. 2022;29(1):1-6.
23. Eccleston C, Fisher E, Howard RF, Slater R, Forgeron P, Palermo TM, et al. Delivering transformative action in paediatric pain: a Lancet Child & Adolescent Health Commission. The Lancet Child & Adolescent Health. 2021;5(1):47-87.
24. Tenforde AS, Borgstrom HE, DeLuca S, McCormack M, Singh M, Hoo JS, et al. Best practices for extracorporeal shockwave therapy in musculoskeletal medicine: Clinical application and training consideration. Pm & R. 2022;14(5):611.

Appendix 1. PRISMA flowchart of articles which informed the position statement



Appendix 2. Included studies and outcome domain

Primary Author	ICD-11 coding	Population	Outcome timepoint	ICF Domains	ICF Category	Outcome measures
Moretti (21)	**FB82.1** - Osteochondrosis or osteochondritis dissecans	Aged 14 years female (n=1)	Not stated	Body functions Activity	**b28015** Pain in lower limb **b749** Muscle functions, other specified and unspecified **d9201** Sports	Visual analogue scale Passive range of movement Number of times per week playing elite sport
Lin (19)	**8D20.1** - Spastic bilateral cerebral palsy	Aged 6 to 12 years (n=82)	8 weeks	Body functions	**b7350** Tone of isolated muscles and muscle groups	Modified Ashworth Scale
Ikoma (17)	**FB40.2** Posterior tibial tendonitis	Aged 14 years (n=1)	2 years	Body functions Activity Participation	**b28015** Pain in lower limb **b749** Muscle functions, other specified and unspecified **N/A** Alignment of the joints and bones **d9201** Sports **d599** Self-care, unspecified **d729** General interpersonal interactions, other specified and unspecified **d5404** Choosing appropriate clothing **d570** Looking after one's health	Visual analogue scale American Orthopaedic Foot and Ankle Society Score (AOFAS) The Japanese Society for Surgery of the Foot (JSSF)
Emara (15)	**8D20.0** Spastic unilateral	Aged 7 to 9 years	12 weeks	Body functions	**b7303** Power of muscles in lower half of the body	Peak eccentric torque Torque threshold

	cerebral palsy	(n=45)			**b755** Involuntary movement reaction functions **b760** Control of voluntary movement functions **b7350** Tone of isolated muscles and muscle groups	Single leg standing test GMFM-88 (Gross motor function) Modified Ashworth scale Selective voluntary motor control (SVMC)
Amelio (11)	**8D20.0** Spastic unilateral cerebral palsy	Aged 6 to 11 years (n=12)	12 weeks	Body functions	**b7350** Tone of isolated muscles and muscle groups	Modified Ashworth scale
Gawad (8)	**8D20.1** Spastic bilateral cerebral palsy	Aged 5 to 6 years (n=30)	4 weeks	Body functions	**b7350** Tone of isolated muscles and muscle groups **b7508** Other specified motor reflex functions **b770** Gait pattern functions	Modified Ashworth scale H/M ratio measurement 3D gait analysis
Park (20)	**8D20** Spastic cerebral palsy	Aged 2 to 13 years (n=12)		Body functions	**b7350** Tone of isolated muscles and muscle groups **b749** Muscle functions, other specified and unspecified	Modified Ashworth scale Passive range of movement
Kwon (18)	**8D20** Spastic cerebral palsy	Aged 2 to 13 years (n=15)		Body functions	**b749** Muscle functions, other specified and unspecified	Passive range of movement
Gonkova (16)	**8D20** Spastic cerebral palsy	Aged 18 months to 18 years (n=25)	4 weeks	Body functions	**b7350** Tone of isolated muscles and muscle groups **b749** Muscle functions, other specified and unspecified **b770** Gait pattern functions	Modified Ashworth scale Passive range of movement Pressure Foot contact areas
Altindag (10)	**8D20** Spastic cerebral palsy	Aged 12 to 14 years (n=2)		Body functions	**b7350** Tone of isolated muscles and muscle groups	Modified Ashworth scale
Elnaggar (12)	**8D20** Spastic cerebral palsy	Aged 5 to 8 years	4 weeks	Body functions	**b7508** Other specified motor reflex functions	H/M ratio measurement Functional balance

		(n=60)			**b755** Involuntary movement reaction functions **b770** Gait pattern functions	3D gait analysis
Elnaggar (13)	**EK5Y** Other specified skin disorders provoked by external factors	Aged 6 to 18 years (n=45)	4 weeks	Body functions	**b749** Muscle functions, other specified and unspecified **b770** Gait pattern functions	Passive range of movement 3D gait analysis
Wardhani (22)	**8D20** Spastic cerebral palsy	Aged 5 to 12 years (n=14)	12 weeks	Body functions	**b7350** Tone of isolated muscles and muscle groups	Australian Spasticity Assessment Scale
Elnegamy (14)	**8D20** Spastic cerebral palsy	Aged 5 to 8 years (n=30)	12 weeks	Body functions	**b7508** Other specified motor reflex functions **b770** Gait pattern functions	H/M ratio measurement 3D gait analysis
Allam (9)	**8D20** Spastic cerebral palsy	No specific age group (n=40)	12 weeks	Body functions	**b7350** Tone of isolated muscles and muscle groups **b770** Gait pattern functions	Modified Ashworth scale 3D gait analysis

Appendix 3. Figure 1a is the Risk of bias of randomised control trials and Figure 1b is the risk of bias from non-randomised trials

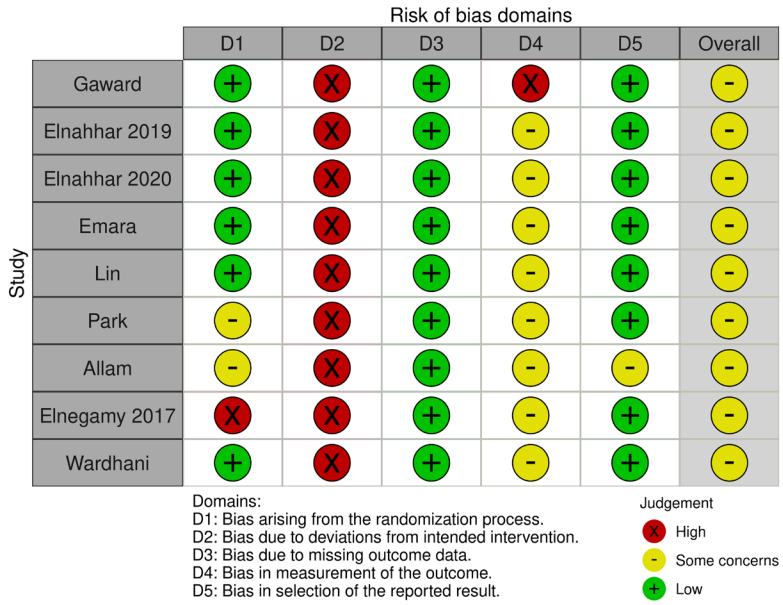
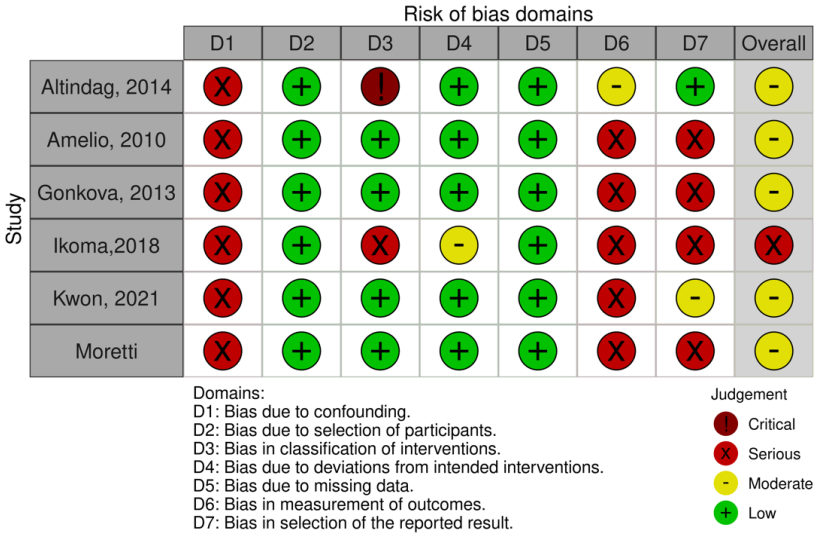


Figure 1a Risk of bias of randomised trials



Appendix 4. ESWT manufacturer statements relating to use on children and teenagers

Brand	Manual reference	Position category	Statement relating to children and teenagers or conditions this age group is more likely to present with
Chattanooga Focus Shockwave	13 370 02 0518	Contraindications	1.1.2 Over or near bone growth centre until bone growth is complete
Chattanooga Focus Shockwave	13 370 02 0518	Precautions	1.1.4 The safety and effectiveness of the Chattanooga Intelect F-SW USA has not been demonstrated in patients with the following conditions/observations 1. Children less than 18 years of age 2. Inflammation of the lower and upper ankle 3. History of rheumatic diseases, and/or collagenosis and/or metabolic disorders 12. Bilateral painful heel, if both feet need medical treatment 20. History or documented evidence of systemic inflammatory disease such as rheumatoid arthritis, osteoarthritis, ankylosing spondylitis, aseptic bone necrosis, Reiter's syndrome etc.
Storz Medical Duolith SD1 T-TOP F-SW	March 2021	Contraindications	2.1.2 Over or near bone growth centre until bone growth is complete
Storz Medical Duolith SD1 T-TOP F-SW	March 2021	Precautions	2.1.5 The safety and effectiveness of the Duolith SD1 has not been demonstrated in patients with the following conditions/observations 1. Children less than 18 years of age

			2. Inflammation of the lower and upper ankle 3. History of rheumatic diseases, and/or collagenosis and/or metabolic disorders 12. Bilateral painful heel, if both feet need medical treatment 20. History or documented evidence of systemic inflammatory disease such as rheumatoid arthritis, osteoarthritis, ankylosing spondylitis, aseptic bone necrosis, Reiter's syndrome etc.
Chattanooga Intelect RPW 2	2021	Caution	- There is a potential for discomfort when using the device on bony surfaces - Be aware of the potential for bruising and hematoma - Never use this device on children, the unconscious or anyone who cannot give verbal consent or warnings about pain
Chattanooga Intelect RPW 2	2021	Additional precautions	When administering Radial Pressure Wave treatment, keep in mind the following: - Radial Pressure Wave treatment should be applied with caution over bone where minimal (bony prominence) or no (Stage IV wounds) soft tissue is present - Patients with active autoimmune diseases may not respond positively with the treatment
Chattanooga Intelect RPW Shockwave	2011	Additional precautions	When administering Radial Pressure Wave treatment, keep in mind the following: - Radial Pressure Wave treatment should be applied with caution over bone where minimal (bony prominence) or no (Stage IV wounds) soft tissue is present - Patients with active autoimmune diseases may not respond positively with the treatment
Chattanooga Intelect Mobile 2 RPW Shockwave	REF 2905-US	Caution	- There is a potential for discomfort when using the device on bony surfaces - Be aware of the potential for bruising and hematoma - Never use this device on children, the unconscious or anyone who cannot give verbal consent or warnings about pain
Chattanooga Intelect Mobile 2 RPW	REF 2905-US	Warning and precautions	- Do not use in the presence of unexplained pain - Use of this device may be painful or cause bruising. NEVER use

Shockwave			this device on children, the unconscious or anyone who cannot give verbal consent or warnings about pain - Caution should be used over joints or bony prominence such as vertebrae
EMS – Dolorclast (all machines)	https://www.ems-dolorclast.com/faq	Contraindications	- treatment of patients under the age of 18 (except for the treatment of Osgood-Schlatter disease)
Gymna Guided Therapy system	0197	Contraindications	- Children in growth
Masterpuls One	N/A	N/A	N/A
Masterpuls MP200	May 2016	N/A	N/A
Dornier AR2	1999	Precautions	- Under 18 years of age - A history or documented evidence of autoimmune disease, bleeding disorder or haemophilia, peripheral vascular disease, Type I or Type II diabetes mellitus, systemic inflammatory disease such as rheumatoid arthritis, ankylosing spondylitis, Reiter's Syndrome etc, and/or generalized tumour in the areas to be treated - Calcaneal stress fracture as evidenced by positive squeeze test